ENGINEERING NEWS

A JOURNAL OF CIVIL, MECHANICAL, MINING AND ELECTRICAL ENGINEERING

Vol. 65. No. 26. 220 Broadway, New York, June 29, 1911.

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Freight Station With Equipment for Mechanical Handling of Freight: Missouri, Kansas & Texas Ry.; St. Louis, Mo.

One of the most interesting of the many terminal freight stations of recent construction is that recently completed at St. Louis, Mo., by the Missouri, Kansas & Texas Terminal Co. This company is an auxiliary of the Missouri, Kansas & Texas Ry. Its Chief Engineer is Mr. S. B. Fisher, M. Am. Soc. C. E., who planned the general layout and provided for the introduction of a system of mechanical handling of the freight. The station is of interest on account of its general design and construction, but more especially from the fact that it was designed for the mechanical handling of freight by means of an electric telferage system.

The station is located in the north part of the city, at Mullanphy St. and Broadway. Its general design and arrangement are shown in Figs. 1 and 2. In plan it is about 403 × 232½ ft., as shown in Fig. 1. On the Broadway front (403 ft.), the first floor is at the street level, but at the rear (owing to the slope of the ground) the ground is level with the basement floor. The tracks run north and south (parallel with Broadway) and extend through the building at the basement level. The four team driveways are on the first floor, opening from (and at right angles to) Broadway. Two of the platforms do not extend to the rear of the building, so that there is a transverse rear driveway by which wagons can pass from one of each pair of driveways to the other. In this way circulation of traffic is provided for, eliminating opposing movements and the liability for congestion. The track floor (in basement) has its rails 20 ft. below the floor line of the driveways, and has a

INTERIOR OF TEAM FLOOR OF ST. LOUIS FREIGHT STATION EQUIPPED WITH ELECTRIC TELFERAGE SYSTEM FOR HANDLING FREIGHT; MISSOURI, KANSAS & TEXAS RY.

(The white portion at the left is one of the driveways opening from the street (Broadway). The hatchways in the platforms are over the train platforms of the lower floor and provide for raising and lowering freight by the telfers or traveling trolley hoists on the overhead runways. The small piles of freight are loaded on wheeled platforms which are picked up by the telfers. On the column in the middle will be seen one of the jib cranes for unloading wagons. Several of the runways can be seen, and at the left is one of the switches connecting the longitudinal runways with the transverse runway along the Broadway side.)

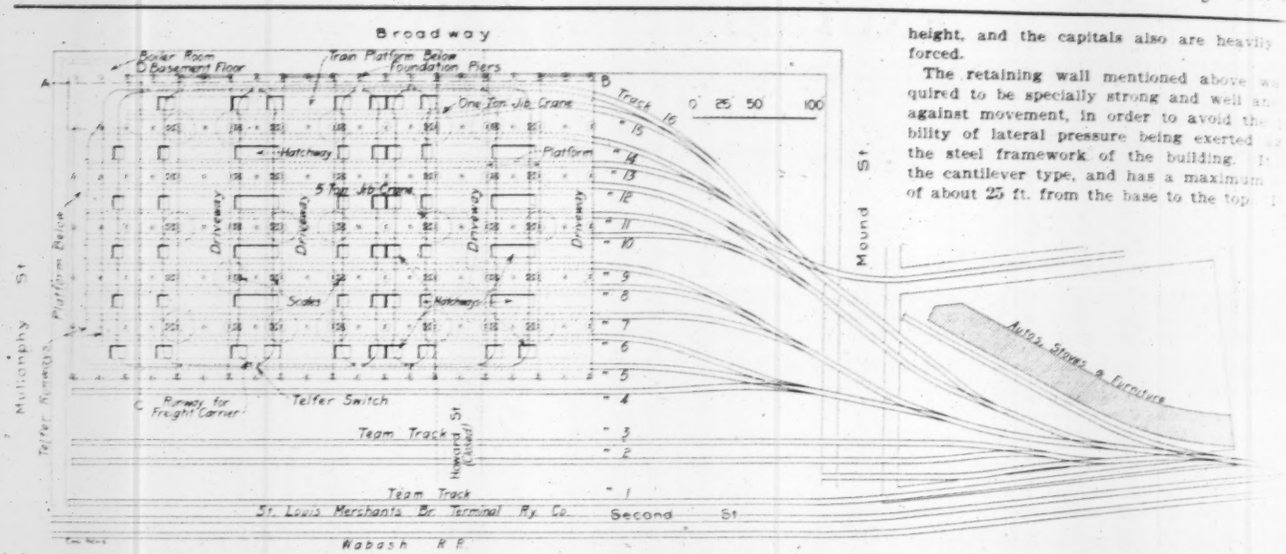


FIG. 1. GENERAL PLAN OF THE NEW FREIGHT STATION OF THE MISSOURI, KANSAS & TEXAS TERMINAL CO.; ST. LOUIS, MO.

S. B. Fisher, M. Am. Soc. C. E., Chief Engineer.

(The team driveways and platforms are on the first floor and the tracks and train platforms are on the basement level.)

clear headway of 16 ft. from the rails to the first floor girders which span the tracks. The team floor (or first floor) has a height of 27 ft. in the clear from the driveway to the beams supporting the upper floor in order to allow ample room for the telfer tracks; the clear headway between the platforms and the telfer runways is 23 ft. 6 ins. The building is designed to have two upper floors for warehouse purposes. At present, however, the upper stories are omitted, except that two bays of the second story, across the building, have been built for office purposes; this gives an area 80 × 232½ ft.

On the Broadway level there are four 36-ft. driveways, separated by three platforms; two of these are 44 ft. wide and one is 82 ft. wide, while another 80-ft. platform extends along the rear end of the building. In the platforms are rows of hatchway openings 10 × 12 to 10 × 33 ft.; these are directly over the train platforms below and each is served by one or more of the telfer lines. Through these the freight is raised and lowered by the trolley hoists of the telferage system.

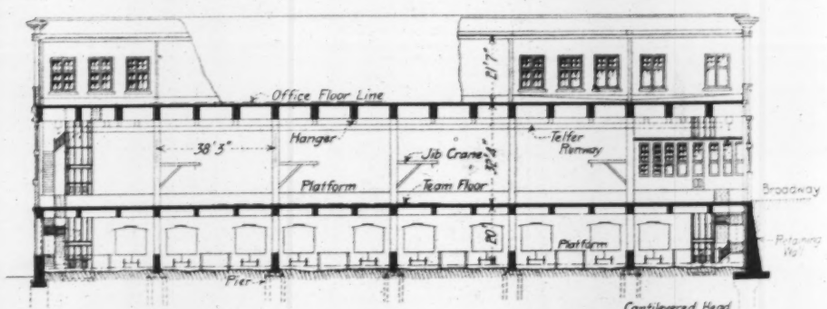
Structural Design.

The building is of combination steel and reinforced-concrete construction. The columns are of steel, and support steel plate-girders forming bays 20 × 38¼ ft. in the basement and 40 × 38¼ ft. above the basement. Each bay is subdivided by girders or beams; in many of the panels of the first floor, where the spans are but 20 ft., reinforced-concrete beams are used, framing into the steel plate girders, as shown in Fig. 3. This construction effects a considerable saving over all-steel framing. The steel columns and girders are all encased in concrete as a protection against fire. The roof (which will be the second floor when the building is completed) is covered with cinders and a thin concrete slab, over which is composition roofing.

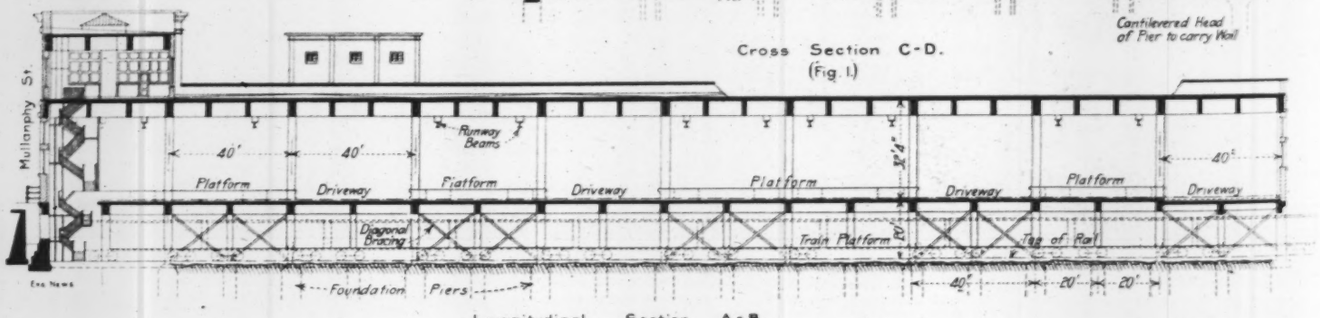
The foundations are concrete piers, carried down to rock by open excavation. They are 3½ to 6½ ft. diameter, and have a maximum depth of 22 ft. below basement floor line. The main piers are 40 ft. apart longitudinally and 38 ft. 3 ins. transversely, but in the longitudinal direction there are smaller intermediate piers which reduce the spacing to 20 ft., and which support columns extending only to the team floor.

At the top, each pier is reinforced by two or three layers of steel hoops embedded in the concrete. On the Broadway side there is a heavy retaining wall extending to the street level, and this is supported upon the front row of piers. In order to provide the necessary footing area for the wall, the heads of the piers are enlarged by cantilevering them out to form capitals (Fig. 4). In the main piers, under this retaining wall, the diameter is increased from 5½ ft. in the shaft to 9 ft. over the capital, while in the intermediate (alternate) piers under the wall it is increased from 4 ft. to 9 ft. These wall piers have vertical reinforcing rods extending the full height, and the capitals also are heavily reinforced.

The retaining wall mentioned above was required to be specially strong and well anchored against movement, in order to avoid the possibility of lateral pressure being exerted upon the steel framework of the building. It is of the cantilever type, and has a maximum height of about 25 ft. from the base to the top.



Cross Section C-D.
(Fig. 1.)



Longitudinal Section A-B.
(Fig. 1.)

FIG. 2. SECTIONS OF THE FREIGHT TERMINAL.

The retaining wall mentioned above was required to be specially strong and well anchored against movement, in order to avoid the possibility of lateral pressure being exerted upon the steel framework of the building. It is of the cantilever type, and has a maximum height of about 25 ft. from the base to the top. When the columns were erected, these wall sections of the wall were built, each with a buttress enclosing the column. This arrangement, together with the design of the wall, is shown in Fig. 5. This retaining wall extends 440 ft. along the Broadway front, and a plain concrete retaining wall extends for 190 ft. along the Mullanphy St. side. The face of this latter is 4½ ft. beyond the building line and columns, thus providing an areaway for light. The height of this wall reduces from 25 ft. at Broadway to 4 ft. at the east end.

The cast-iron bed plates for the main columns are of unusual design; they are circular in form; 30 ins. high, and 66 and 34 ins. diameter at top and bottom. The central portion is hollow, with grouting holes at top and bottom, and similar holes are formed in the top and bottom plates of the castings. When the bed-plate was adjusted in position, grout was poured into the center until it flowed up through the holes in

the base, showing that the casting was well bedded. The casting was then encased in concrete, and grout poured through holes in the top plate to fill all voids. The top plate has four holes for the column anchor bolts. Each of these large castings was estimated to weigh about 7,080 lbs. For the smaller intermediate columns, rectangular bed-plates were used, weighing 670 and 865 lbs.

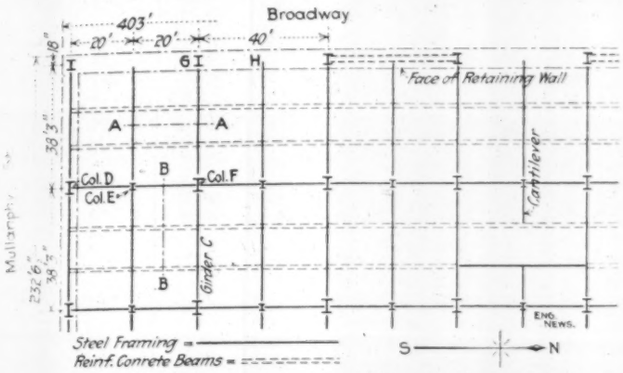


FIG. 3. PART PLAN OF STEEL FRAMING OF FIRST FLOOR.
(Carrying the team driveways and platforms.)

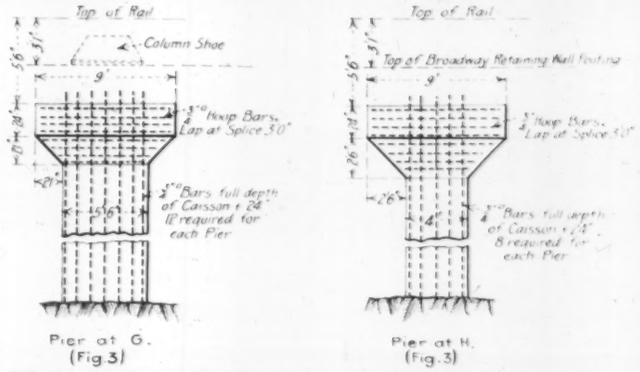

Top of Rail
Column Shoe
Hoop Bars, Lap at Splice 50"
Bars full depth of Caisson + 24" If required for each Pier
Top of Broadway Retaining Wall Footing
Bars full depth of Caisson + 24". 8 required for each Pier
Pier at G. (Fig. 3)
Pier at H. (Fig. 3)

FIG. 4. CANTILEVERED HEADS OF FOUNDATION PIERS SUPPORTING THE BASE OF A CANTILEVER RETAINING WALL.

The steel columns are of H-section. The main columns have four angles 7 × 3½ × ¾ ins., a web plate ⅝ × 16 ins., and four side plates ⅞ × 21 ins. In the lower section, there are four reinforcing plates riveted to the angles and web plate. The use of short-flanged angles enables the column to be built with only two lines of riveting in the web, above the first floor; this plan was adopted in view of the fact that sufficient stiffness would be afforded by the concrete casing. The columns are in two-story lengths, or 57 ft. 8¼ ins. high from the shoes. After they had been designed, it was decided to raise the second story level 18 ins. Fortunately, it was found possible to provide for this change by a slight change in the splices, which involved only a small expense and did not reduce the strength. In the basement, longitudinal diagonal bracing is introduced between some of the columns, as shown. This consists of single angles 6 × 4 ins., and was provided mainly as a safeguard during erection.

The arrangement of the girders supporting the first floor is somewhat peculiar. In the original design, there was to be a continuous concrete floor at the level of the driveways. Upon this the platforms were to be supported by temporary steel or wooden framing, so that changes in the tracks and platforms could be made as desired. After the plans were made, it was decided that the platform arrangement should be made permanent, and that the platforms should be supported therefore on permanent girders. Thus, the platforms as built are above the level of the cross girders, while the natural arrangement (but for the condition noted above) would have been to place these girders immediately beneath (and integral with) the platform slab.

The main steel girders of the first floor are 34¼ ins. deep; the web and lower chord are encased in concrete, while the upper chord is embedded in the concrete slab of the driveway or the floor. To carry the intermediate first-floor girders of reinforced concrete, steel brackets or shoes are riveted on the girder webs. The steel and concrete girders of this floor are shown in Fig. 6.

The second floor has 54-in. longitudinal girders and 52-in. transverse girders, all encased in concrete. These girders are shown in Fig. 7. Some of the steel girders have a special top chord construction for the purpose of better supporting the reinforced-concrete floor slab and supporting the reinforcing bars during erection. In these girders, the web plate is extended above the flange angles and has side plates riveted gainst this upper part (Fig. 7). Cross frames and sway bracing are fitted between the girders. The longitudinal girders carry the hangers to which are attached the I-beams of the telfer runways (Figs. 7 and 8).

The concrete floor slab of the first floor is 9½ ins. thick, and is covered with 4½-in. wood block paving on the driveways. It is designed for a live load of 300 lbs. per sq. ft. on the platforms and driveways. The floor slabs for the upper floors (part of which only are built at present) are 7 ins. thick, and are designed for live loads of 250 lbs. per sq. ft. The intermediate concrete girders are built integrally with the floor slabs, as shown in Fig. 6.

The general plan and layout was prepared by Mr. S. B. Fisher, Chief Engineer of the Missouri, Kansas & Texas Ry. The design of the building was made by Widmann & Walsh, architects, of St. Louis, and the structural design of the building was prepared by Condron & Sinks, consulting engineers, of Chicago. The steel work was built at the Detroit shops of the American Bridge Co. The general contractors were James Stewart & Co., of St. Louis; they put in the foundation piers and retaining walls, erected the steel work, did the concreting, and finished the building complete. The excavation for the site was done by the Parker Washington Co., of St. Louis.

The general particulars of the building and its freight handling equipment are as follows:

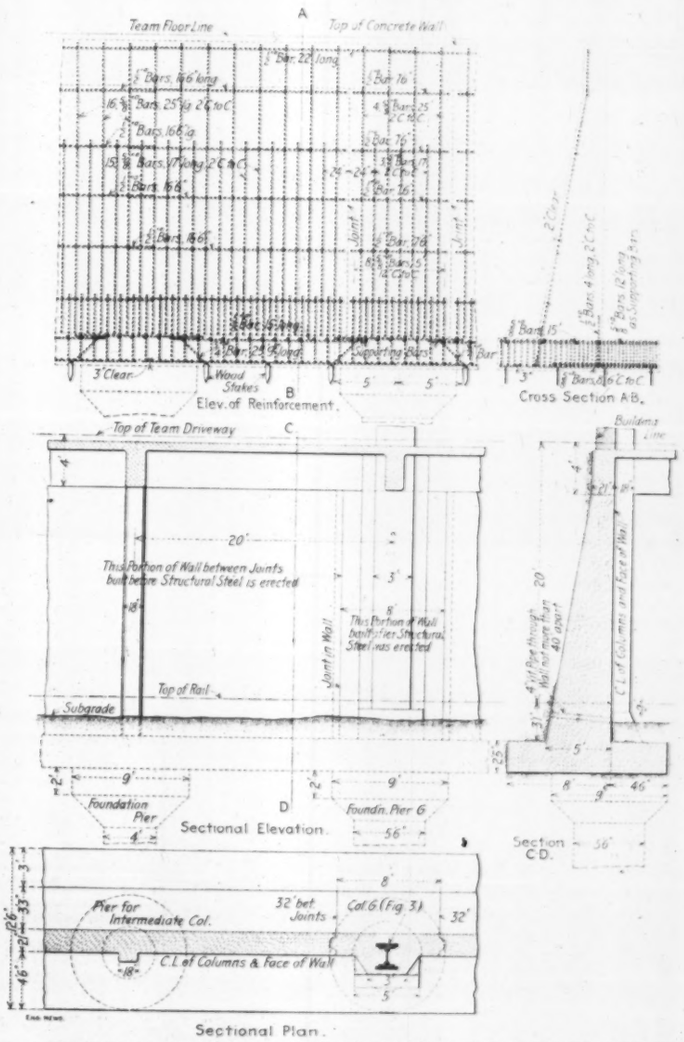


FIG. 5. REINFORCED- CONCRETE RETAINING WALL OF THE CANTILEVER TYPE.

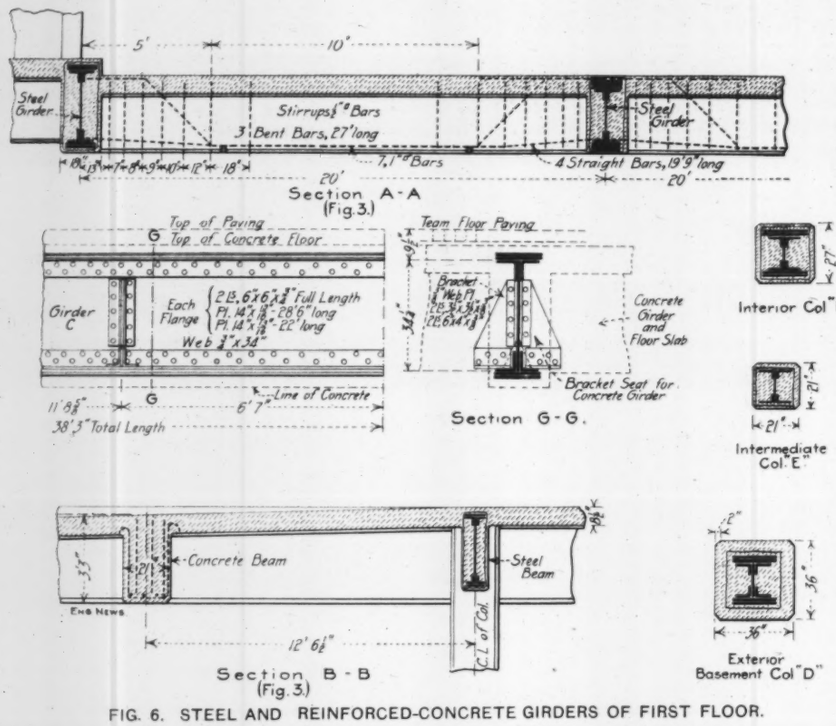


FIG. 6. STEEL AND REINFORCED-CONCRETE GIRDERS OF FIRST FLOOR.

Size of building	403 × 232½ ft.
No. of railway tracks	12
Length of railway tracks (within building)	4,800 ft.
No. of cars on station tracks	117
Area of platforms on team floor	55,800 sq. ft.
Area of platforms on track floor	28,800 sq. ft.
No. of hatchways in team-floor platforms	37
No. of freight scales	20
Total length of telfer runways	3,177 ft.

Freight Handlfng Equipment.

Of special interest is the equipment for the mechanical handling at this station. The freight consists of miscellaneous or package freight such as is hauled in less-than-carload lots; it includes such diversified materials as wrought iron pipe, plate glass, castings, sacks, barrels, bundles, boxes and bales of all kinds. The packages have to be weighed, sorted and checked in the usual way. Outbound freight is delivered by wagons on the upper floor, and must be unloaded, weighed, sorted, and delivered to the freight cars on the lower floor. The arrangement and capacity of the tracks provides a maximum of 54 destinations or points to which the freight must be delivered. Inbound freight must be unloaded and delivered to any desired part of the platforms on the upper floor. The daily duty required is as follows: (1) to load 1,000,000 lbs. in five hours in the afternoon into 77 freight cars on the lower floor, each with an average of 1,200 cu. ft. of miscellaneous freight taken from the upper floor; (2) to handle a less amount of inbound and outbound freight in the morning; (3) the system installed to permit of increasing the capacity easily and at slight expense so as to provide for loading 108 cars in five hours.

It was decided that these requirements could best be met by the telferage system; this consists of trolley hoists traveling on overhead runways and carrying suitable trucks (suspended from the hoist) on which the freight is loaded. Each trolley has electric motors for the propelling gear and hoisting drums, and carries a motorman who controls the traveling and hoisting movements. This system has been applied extensively in manufacturing and industrial establishments, and an equipment of this sort has been in use for some time at a pier of the Old Dominion Steamship Co., at Norfolk, Va. This was mentioned in our issue of March 25, 1909, in connection with a description of some proposed telferage installations for freight stations. There is a more recent installation in a freight pier of the Baltimore & Ohio Ry. at Baltimore, Md., but this has been worked as yet only for a very small part of its capacity.

The telferage system for the freight house at Kansas City has the special feature of being required to handle material upon and between two floors, one floor for railway cars and one for wagons. Its purpose is to carry packages from any point on one floor to any point on the other floor. This is provided for by means of the numerous hatchways, already mentioned, which are located beneath the overhead runways. In effect, each telfer or trolley hoist is a portable elevator (with a detachable platform), and each hatchway is an elevator shaft free of guides or other fixed equipment. This system was proposed by the Sprague Electric Works, of New York, and the plans provided for a supplementary service of jib cranes for unloading the wagons. These plans were adopted, and the building was designed to accommodate this plant, which has been installed and put in operation.

The freight from wagons and railway cars is loaded on wheeled trucks or carriers which are run along the platforms to a position under the runways so that they can be picked up by the trolley hoists. One of these trolleys or telfers, with loaded carrier, attached, is shown in Fig. 9. Electric jib cranes attached to the columns of the upper (team) floor serve to unload the inbound freight from wagons, weigh it, and then place it on the carriers. Inbound freight is transferred from the carriers to wagons in the same way. Each crane has an electric hoist mounted on the mast and connected with a carriage traveling on the horizontal boom; the movement of the carriage and the swinging of the crane (through 360°) are effected by hand. Collector rings provide for the supply of current at any position of the crane. The crane design is shown in Fig. 10.

The runways of the telferage system are suspended beneath the ceiling of the upper floor (for teams), the height of this story being made sufficient for this purpose, as already described. There are two runways over each of three platforms and four over the wide platform (on the upper floor), being located directly over the rows of hatchways, as shown in Fig. 1. These ten longitudinal tracks are connected at each end to a cross track by means of 15-ft. curves and switch connections, so as to form one complete system. Thus a telfer or hoisting trolley can go from any one point to any other point on the runway system. The runway (Fig. 11) consists of an 18-in. 55-lb. I-beam, the bottom flange of which is 26 ft. 1 in. above the floor. On the bottom flange are carried two 20-lb. T rails, mounted on a hardwood cushion or filler in order to reduce noise and vibration. The rail joints are fitted with steel inserts in the rail head to prevent shock and noise of wheels. The switches consist of 5-ft. sections of the runway, arranged to slide on tracks at right angles to the line of the runway (Fig. 12). The switch is operated by a motor and its operation can be controlled by the motorman on an approaching trolley hoist by means of an electric switch. The position of the runway switch is indicated by signal lights, a red light showing the motorman that the switch is set for the other track.

Each telfer (Fig. 9) consists of a pair of four-wheel trucks with 10-in. wheels, carrying a frame for the hoisting drums, motors, etc. Each

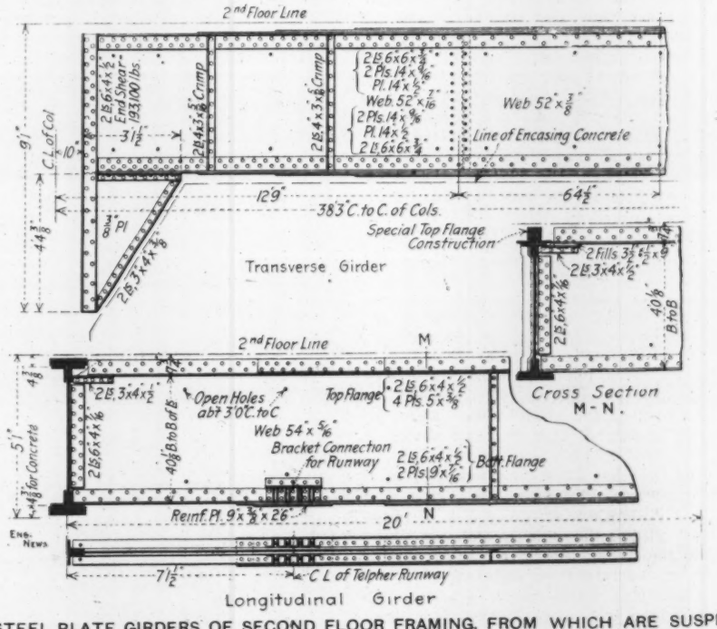


FIG. 7. STEEL PLATE GIRDERS OF SECOND FLOOR FRAMING, FROM WHICH ARE SUSPENDED THE OVERHEAD RUNWAYS FOR THE TELFERAGE FREIGHT-HANDLING SYSTEM OF THE FIRST FLOOR.

½-ton trolley has a 25-HP. motor for hoisting and two 6-HP. motors for traveling; on the 2-ton trolleys the motors are of 9 HP. and 3½ HP. respectively. The speeds are approximately 60 ft. per min. for hoisting, 120 ft. for lowering, and 700 ft. for traveling. Direct current at 230

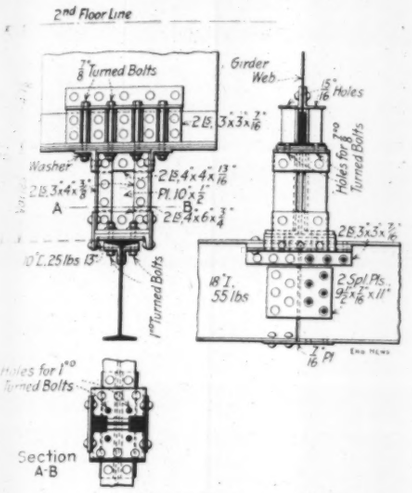


Fig. 8. Telfer Runway and Hanger.

volts is led along the runways by angle irons and collected by shoes on the trucks of the telfers. Each telfer has two hoisting drums connected together and operating in unison, but each having its own rope and hook. This arrangement is designed to prevent swinging of the load. The two hoisting ropes are attached to grapples having hooked ends to engage with projections on the freight carriers. These bars are so fitted as to unhook or disengage automatically as soon as the carrier is lowered so as to rest on the floor. The freight carrier consists of a platform 4 × 6½ ft. supported on two 10-in. side wheels and provided with a caster at each end. This arrangement facilitates turning the carrier. The platform is 10⅝ ins. above the ground. It is provided with lugs for the hoisting grapples and with stakes to sustain the load. The carrier, even when fully loaded, can be moved along the platform or up an inclined gangway by one man by means of a ratchet lever acting through gears on the axle of the side wheels.

The operation of a number of metal trucks with metal wheels on metal runways is liable to result in considerable and undesirable noise unless special means are taken to prevent this. To ensure quietness of operation the following features are introduced: (1) all gears, except those attached to the drum and the truck wheels are enclosed in cases and lubricated with grease; (2) a silent load brake or load controlling device without teeth is provided, to avoid the clattering of a pawl on ratchet teeth; (3) the runway is designed with smooth and even joints; (4) the runway is designed with an insulating cushion of wood under the rails which carry the truck wheels, so as to reduce or eliminate the ringing of the runway due to vibration.

The equipment now provided for includes 16 telfers of 2 tons carrying capacity, two telfers of 6 tons capacity, 100 wheeled trucks or package holders on which the freight is transported, and 17 jib cranes (3 of 5 tons and 14 of 1 ton capacity). Each telfer requires a motorman. Increased capacity may be obtained readily and at small expense by installing additional telfers and package trucks.

The general plan of operation is as follows: Wagons containing miscellaneous outbound freight unload at any point on the elevated platforms. The freight is picked up by the jib cranes or by hand, weighed and placed under the runway, either on package holders or piled directly on the floor. The loaded package holders are hooked onto the hoists by men on the floor. Each package holder is destined for a certain freight car, and is transported to and lowered through the hatchway nearest the car. As each package holder reaches the freight car floor it is automatically disengaged from the grapple, and is subsequently wheeled into the freight car and unloaded by the car stowers. Inbound freight is handled in the same way. The package carriers are loaded in the cars or at the car doors, and are wheeled to position beneath the nearest hatchway in the floor above. A telfer then hoists the carrier to the upper floor and carries it to the desired point on any of the platforms of that floor, from which the freight is transferred in wagons.

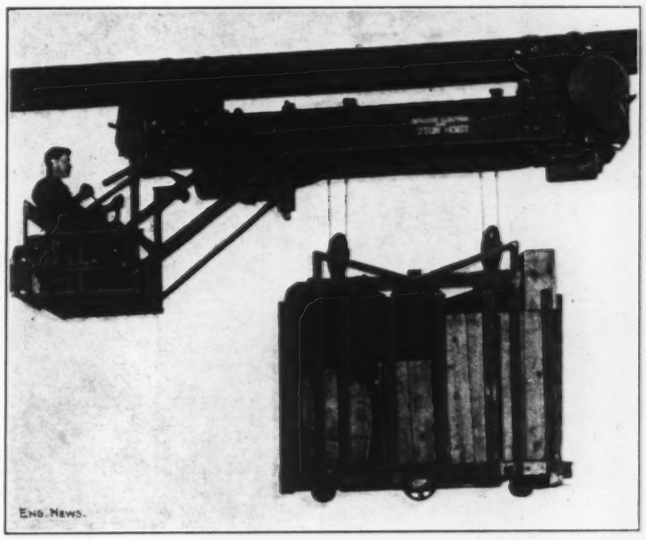


FIG. 9. TWO-TON ELECTRIC TELFER CARRIAGE OR TROLLEY HOIST, WITH LOADED FREIGHT CARRIER SUSPENDED FROM THE HOIST.
(Sprague Electric Works, New York, N. Y., Builders.)

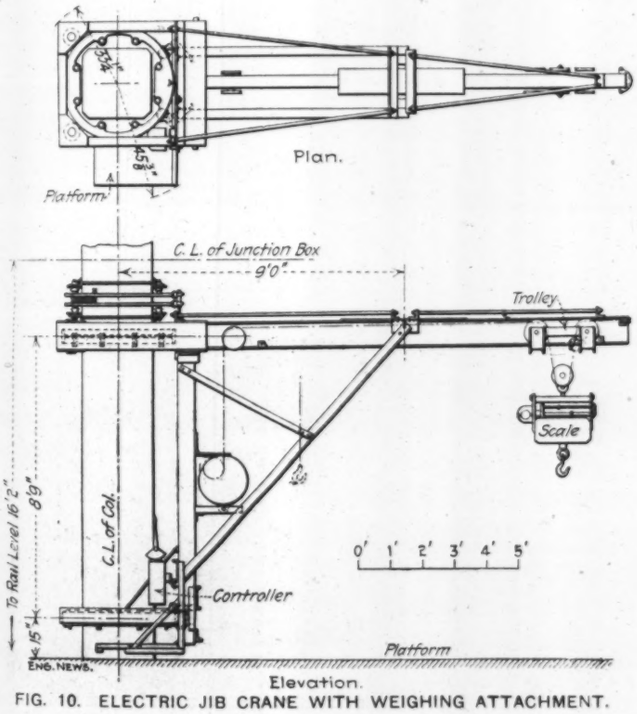


FIG. 10. ELECTRIC JIB CRANE WITH WEIGHING ATTACHMENT.

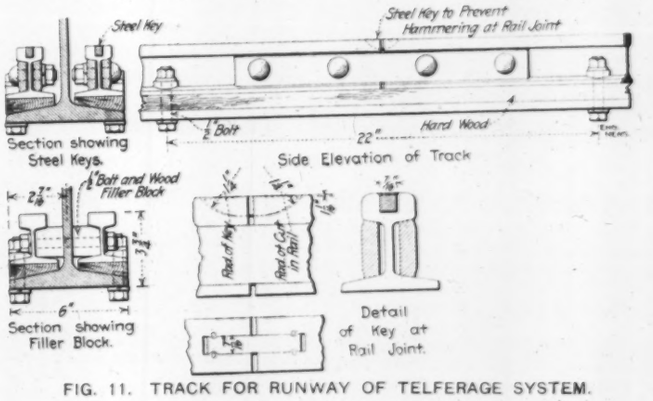


FIG. 11. TRACK FOR RUNWAY OF TELFERAGE SYSTEM.

THE 5-TON SAURER TRUCK which is making a transcontinental journey as an exhibition of its capabilities, and which traveled in the Spring from Denver to Los Angeles and thence to San Francisco, left Pueblo, Colo., bound eastward on June 12. The truck was shipped by rail from San Francisco to Pueblo, having already covered that part of the transcontinental journey in the reverse direction. Kansas City was reached on June 18, the run of 700 miles from Pueblo having been made in 70 hours actual running time, including 8 hours delay when the truck (which weighs about 14,000 lbs. with its load) broke through a high trestle bridge west of Hutchinson, Kan.

BRITTLENESS OF METALS CAUSED BY CORROSION.—The problem of corrosion does not lie in the amount of metal lost by rust or decay, but on the influence exerted on the metal remaining intact and apparently unaffected. Deterioration is found which is not explained by mere loss in weight or by change in the ordinary composition of the metal.

In the case of non-ferrous alloys Arnold showed in 1898 the possibility of failure due to deterioration or dezincification of brazing solders and Muntz metal. In 1903 Milton and Larke, in a paper on the decay of metals, gave many instances of deterioration in non-ferrous alloys and also in cast-iron. Generally speaking these examples represent definite chemical change in the composition induced by external causes.

With steels any evidence of chemical change is not easily found, and although physical changes are apparent these cannot be explained on the ground of definite change in composition. It is not easy to follow the brittleness induced in steel when subject to corrosive action.

The embrittling effect induced by immersion in fairly strong acids is more or less recognized. In many industries, especially that of wire-drawing, acid cleaning in order to remove scale is followed by heating.—From a paper by Percy Longmuir, read before the Iron and Steel Institute.

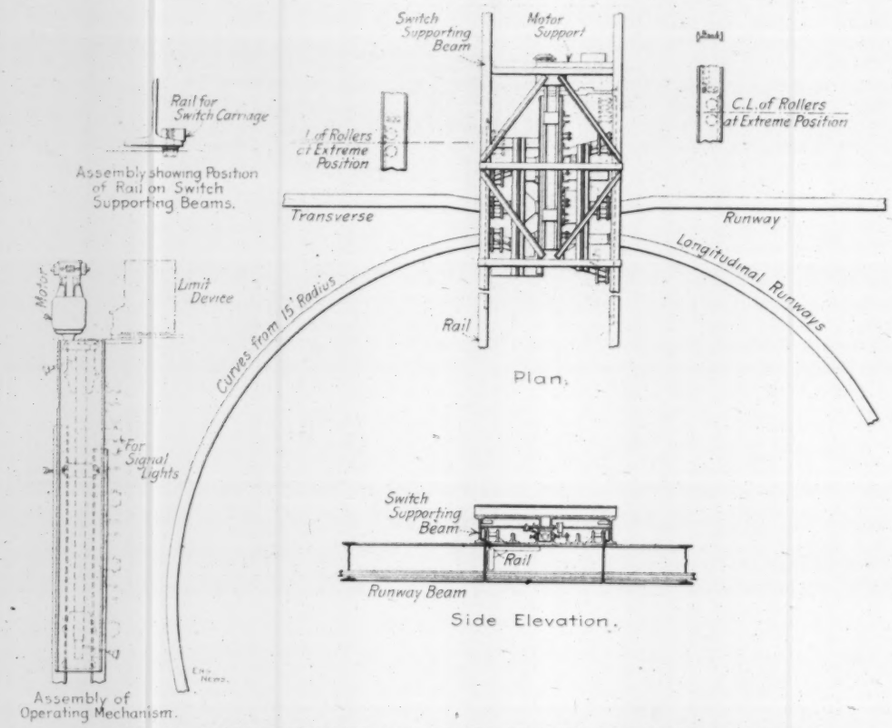


FIG. 12. MOTOR-OPERATED SWITCH FOR RUNWAY OF TELFERAGE SYSTEM.

Japanese Railways.*

By JAMES F. PAIGE.†

Japan has about 5,300 mi. of narrow-gage (3½-ft.) railway. In December, 1867, negotiations were commenced for the introduction of a railway system. The Tokugawa Court desired to conduct the scheme through American assistance, but unfortunately the War of Restoration broke out about this time and civilization was seriously retarded. Shortly after the restoration, the new government began planning railroad construction, but found it difficult to raise the necessary capital in the country, when an English broker, Mr. Lay, promised to supply one million sterling for railway construction at 9% interest. The terms were accepted by the government, but not without stirring up a great national agitation, which took months to overcome. I may say that this was at a time when prejudice against the introduction of foreign things was very strong, and it is said that when the first two-story house was built the Shogun of the time, passing through the country, called the man before him and was very much inclined to give him a term of imprisonment, but let him off with a fine; so that you can see that they would not take in general kindly to the introduction of railway systems. The government, however, held a strong confidence that the railway would do more toward the civilization of Japan than the ancestors had done in the past, and decided to carry out their scheme as planned.

HISTORY.—The first railway office was created March 19, 1870, and under the direction of English engineers work began shortly afterwards. On May 7, 1872, the first train ran through from Tokyo to Yokohama, a distance of 18 mi., and two years later the western division was opened from Kobe to Osaka, 20 mi. By 1883 this line was extended to Tsuruga, on the west coast. On this line is the Yamagese tunnel, near Tsuruga, 4,188 ft. long, one of the longest tunnels in Japan and requiring nearly three and one-half years to complete. Some importance attaches to Tsuruga, as it is the port of departure from Japan for Vladivostok, connecting at the latter port with the great Trans-Siberian Railway.

In the following year, 1884, the Nippon Railway Co., the pioneer of private railways in Japan, opened its first section from Tokyo north, and by December, 1887, had extended to Sendai, the great commercial city of the northeast, some 220 mi. in all. In 1888 the Sanyo Railway Co. was organized, and in due time opened the line from Kobe to Shimonoseki, on the straits, a distance of 329 mi., the most picturesque route in the country. This company had a good reputation for its management, and was called "the New York Central" of Japan.

In 1906, 34 yrs. after the opening of the Tokyo-Yokohama branch, the government was in possession of 1,500 mi., while the private companies had extended their lines up to 3,270 mi. A noteworthy feature of this year was the commemoration of the completion of 5,000 mi. of railway in Japan, which was held at Nagoya, May 20, 1906.

GOVERNMENT OWNERSHIP.—Soon after the Russo-Japanese war a bill was introduced in the Diet providing for the State purchase of all railroads within ten years. As a matter of fact, the purchase was effected within 18 months, the capital invested therein exceeding $210,000,000 gold. Several smaller companies, totaling some 450 mi., were not included. The price to be paid was determined as follows: Twenty times the average of the net profits for the years 1902, 1903 and 1904, divided by the cost of construction and multiplied by the same at the date of purchase. It will be evident from this that roads paying a good dividend got a good price from the Government, and roads not paying a dividend were sold at a sacrifice. Dividends are a more or less elastic thing. For instance, when the Tokyo street railway last year wanted to sell to the Government they were paying 6% dividends according to the sheets produced. The Government could not consider the proposition for the purchase at that time. Later the street railway management appeared before the Government with a bill asking that they be allowed to increase the fare. At that time their balance sheet showed little or no dividend. High finance has reached Japan all right.

The average cost of construction of the Japanese railways per mile was about $45,000, some sections costing $55,000 per mi.

LOCOMOTIVES.—Rolling stock was originally purchased abroad, the first locomotive coming from the celebrated builders of Glasgow, Dubs & Co. Many locomotives have been purchased in America, principally from the Schenectady, Baldwin and Cooke locomotive works. The Japanese engineers favor the English type of locomotive, principally because the center of gravity is considerably lower and they feel it is safer on the curves with the narrow gage. Locomotive and car shops have recently been established, and much new work is done at home.

The Government two years ago decided to establish a central railway works at Hamamatsu, at an estimated cost of $1,000,000, but the project has since been abandoned, partly as the result of financial retrenchment under the Katsura cabinet and partly out of consideration for private enterprise along similar lines. The Japanese government to a marked extent fosters the home industries, and it is an established fact that in many cases when a business has failed to pay a dividend the Government has considerately taken hold of it and operated it, many times at a loss. Notable in this connection is the Wakamatsu steel foundry, where they have a magnificent plant, but where the loss has averaged about $250,000 to $500,000 yearly. They are still optimistic and predict a brilliant future for the iron and steel works.

WIDENING THE GAGE.—At present there is a strong effort being made to secure legislation authorizing the widening of all trunk lines to standard gage. The total cost is estimated to be $225,000,000. Various reasons are advanced in support of this change of the gage, but from personal observation it would appear as though the present system could be made to serve all requirements by improvements such as double-tracking the main line, putting on more through express trains, reducing the time at station stops and cutting down the running schedule. From Tokyo to Yokohama, 18 mi., through express takes 32 min., local express 50 min. From Yokohama to Kobe, 359 mi., the running time of the night express is 14 hrs. (average 25½ mi. per hr.) and of the day express 19 hrs. (average 19 mi. per hr.). One reason advanced by Baron Goto, the Minister of Railways at the present time, in support of his effort to secure the widening of the gage, is the expectation of a vast amount of business with the opening of the Panama Canal. That does not seem quite reasonable, because there will be no occasion to transship freight through Japan which is destined for ports on the continent of Asia, as it would have to be handled twice. Others, again, who see in all these things simply the policy of the military party, claim that it is wanted for the carriage of large guns and ammunition and supplies of war, for taking soldiers in an emergency from the northern part of Japan to the southern part. Being a mountainous country it would entail an enormous cost for the widening of tunnels, if nothing else, and the rebuilding of all their bridges, and would seriously demoralize the traffic meanwhile.

Although a strong influence in the Diet, it is hardly probable that Baron Goto will succeed in securing the required Government support for his scheme of railway reconstruction.

At present there is under construction between the two main stations in Tokyo—Uyeno and Shimbashi—a distance of about three miles, an overhead railway system. The space between the arches is used for bazaars and stores and otherwise availed of. By ordinary rikisha, with a man running a Marathon, it takes about an hour to make the distance between Shimbashi and Uyeno, through the crowded streets; with the overhead railway, they can make the trip across, with the stops, in ten minutes very comfortably.

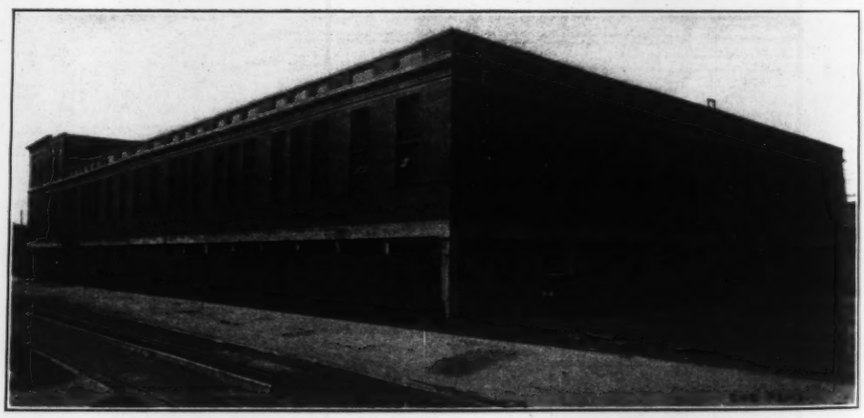


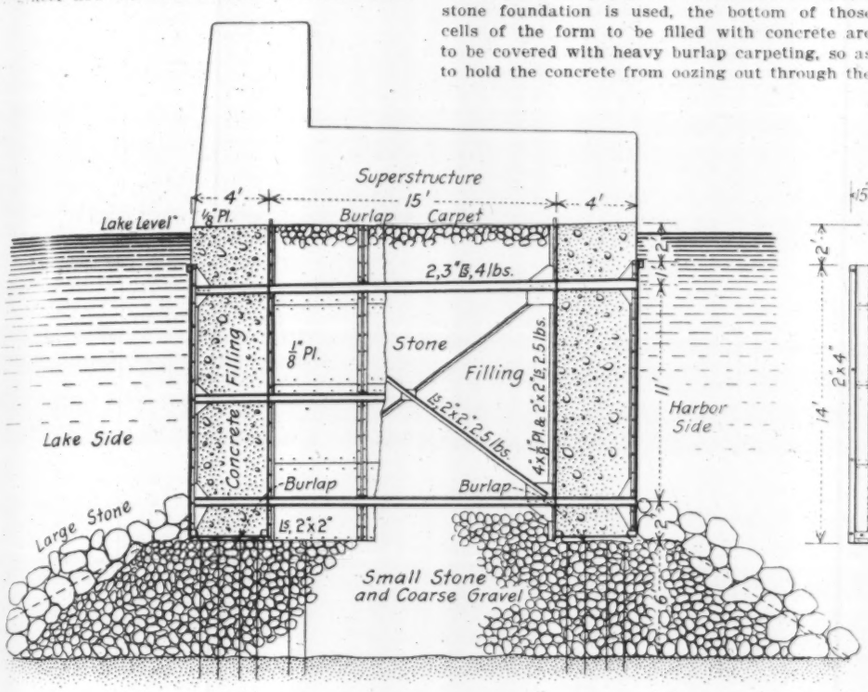
FIG. 13. NEW FREIGHT STATION AT ST. LOUIS, MO.; MISSOURI, KANSAS & TEXAS RY.
(The tracks are on the lower floor and the team driveways on the upper floor, the latter being level with the street (Broadway) at the right-hand side of the view. At the left is an electric traveling gantry crane serving the driveway and outside track. This is for handling heavy or bulky freight. Package freight is handled by an electric telferage system in the building.)

*Extracts from a paper read before the New England Railroad Club, May 9, 1911.

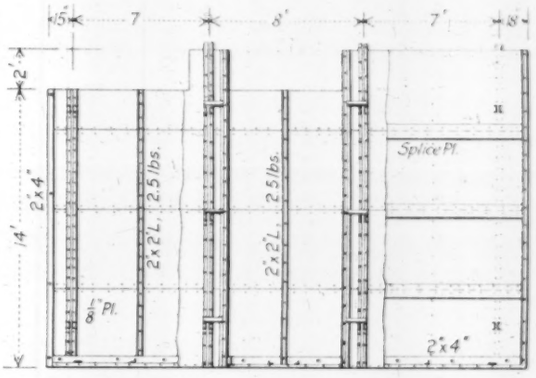
†Assistant Engineer, Fore River Shipbuilding Co., Quincy, Mass.

Steel Forms for Concrete Breakwaters or Piers.

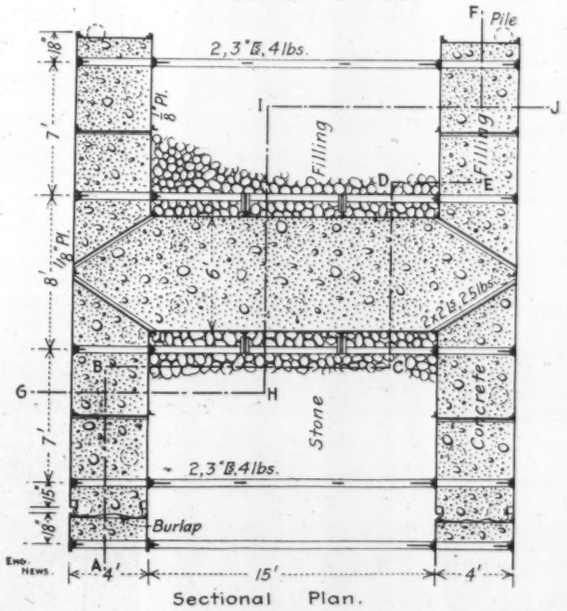
The accompanying drawings show the details of a system of steel forms for building concrete cells for piers or breakwaters, designed by Mr. E. S. Duffies, M. Am. Soc. C. E., U. S. Assistant Engineer now stationed at Harbor Beach, Mich.



Cross Section G-H-I-J.



Longitudinal Section A-B-C-D-E-F.



Sectional Plan.

DETAILS OF STEEL FORMS FOR CONCRETE BREAKWATERS.
(To be sunk in place, filled with concrete and stone, and left in place. Designed by Mr. E. S. Duffies, M. Am. Soc. C. E.)

It is intended that they be used to sink on prepared foundations, be filled with concrete and broken stone and then topped with a concrete or stone masonry upper works as desired, leaving the steel forms in place to rust away.

Each form is in H-section, the legs and cross bar of which are of structural angles and other shapes, covered with steel plates and braced inside and together with angle struts as shown. Each section is to be fabricated in handy size on shore, floated out to its location on a barge and dropped, by derrick, into place on the foundation. The legs and cross bar of the H are then to be filled with concrete and the intervening spaces with broken stone. The upper outer 2 ft. of the form, on both sides is to be removable, so that only concrete will be visible above the water line.

The foundation is to be of the type used in this class of construction. Where the bottom is sufficiently solid, the form may be let down directly upon it with no further preparation than leveling, but ordinarily a broken stone bottom, either plain or piled, will be needed. When a stone foundation is used, the bottom of those cells of the form to be filled with concrete are to be covered with heavy burlap carpeting, so as to hold the concrete from oozing out through the stone. This burlap, while secured firmly to the form, should be ample in width so that it can accommodate itself to the irregularities of the foundation and not tear when the concrete is dumped upon it. Burlap is placed in the legs of the last form set, adjacent to the preceding form so that no concrete will waste between the forms, also so that the concrete will force itself into the irregularities of the preceding form and thus tie the two forms together. Burlap is also placed over the stone filling in the center of the forms to prevent the concrete of the superstructure running down between the stone.

The advantages claimed for these forms are the ease with which they can be erected and placed and their cheapness. As they have only to do temporary service the unit stresses used in their design may be very high and the loads they have to support, that is the pressure of concrete under water, is much less than what ordinary above-water concrete forms have to bear. They may be built on shore at any time and placed only in calm weather, so that no extra strength has to be added to care for wave action. They must be strong and stiff enough to permit of being handled by a derrick preliminary to sinking, but if the other strength requirements are adhered to it is probable that the forms will be sufficiently strong and stiff to stand handling.

The section shown in the drawing is for the intermediate portion of a pier or breakwater, and not for the first or the last form, which would have to have some slight modifications in details. On the drawings also a portion of the sway bracing probably necessary has been omitted. The connection to succeeding forms, as shown at the lower end of the plan, is not integral, but consists merely of a butt joint, with the burlap to permit of expansion between the two sections. In placing the forms, the end adjacent to the preceding form will be held to line and grade by proper guides, while the outer end can be alined in the usual manner. The outside end can be leveled and held to proper grade by two jacks made for this purpose. The forms are to be filled with concrete by buckets or tremies dumping under water. The designer estimates that it should take about an hour to set the form and perhaps five hours to fill it with concrete. The stone filling could then take place at any time as the form would be firmly anchored by the concrete filling.

The form shown in the drawing, for a breakwater or pier 23 ft. wide and about 16 ft. deep, made in 25-ft. lengths, would weigh about eight tons. With flat outside plates this is estimated to cost as follows:

172 cu. yds. concrete (aggregate)	@	$4.50	$774.00
206 bbls. cement		1.50	309.00
411 cu. yds. stone filling		2.00	822.00
24 piles		12.00	288.00
8 tons steel		80.00	640.00
			$2,833.00

Equivalent to $113.32 per lin. ft.

A superstructure of the size outlined on the plans could be built for $38.62 per ft. If corrugated steel plate be used there would be some reduction in cost.

ZINC TAILINGS FOR CONCRETE AGGREGATE have been most successfully used throughout the Missouri-Kansas-Oklahoma zinc and lead district, according to "Mines and Minerals."

Guard Gate and By-Pass Gate, New York State Barge Canal.

At the eastern end of the main or Erie Canal section of the New York State Barge Canal, the line of the Canal leaves the Mohawk River, which it follows for a number of miles east of Rome, and takes a new cut of about two and one-half miles across country to the Hudson River at Waterford, taking a drop of 168.8 ft. through a series of five locks, all located within a section, 1.6 miles long. On account of the crowding of the locks some method had to be taken to preserve enough water for lockage through the series. This has been done by forming a pool between each two locks. These pools are retained by concrete walls extending from the end of the locks to the nearby hills and in these walls sluiceways are cut, through which lockage water may be let. It will be seen that this long and high lock flight requires some guard to prevent the rush of water and of boats down the flight in case of a break at one or more of the locks. This possibility of considerable damage from an accidental smashing of one of the lock gates, such as has occurred several times in the past few years on the canals, at the Sault Ste. Marie, led the engineers to design a more thorough guard gate than is usually provided at lock entrances. Ordinarily, the only safeguard is a movable dam, which is open at normal stages of the canal but which can be shut on short notice in case of emergencies, cutting off the flow of water through the lock. At Waterford, the main flow of the canal is diverted normally through an adjacent sluiceway and the canal prism proper is kept closed by a guard gate, which is opened only to allow boats to pass. The structure is located about 3,300 ft. above the highest lock.

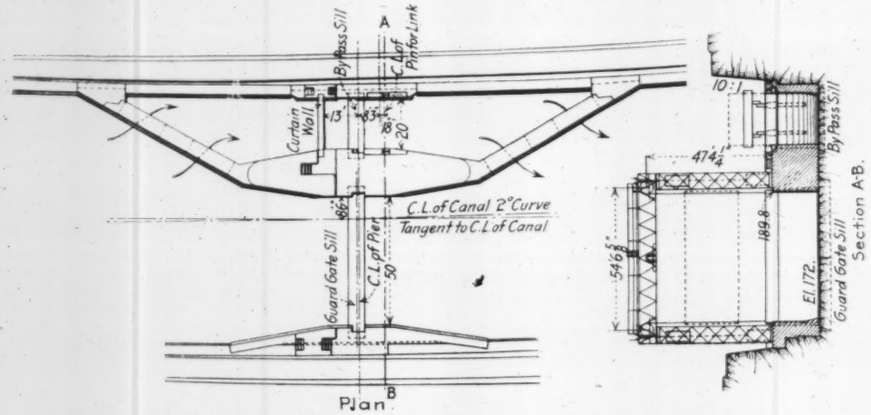


FIG. 1. GENERAL LAYOUT OF THE BY-PASS AND EMERGENCY DAM, NEAR WATERFORD, NEW YORK STATE BARGE CANAL.

Fig. 1 shows the general layout of the structure. It is located on a 2° curve in the deep rock cut through which the canal passes immediately after leaving the river at the Crescent Dam. The clear width between the facing walls in this cut is 94 ft., the standard canal width for rock cuts, and the end abutments for the guard gate and the sluiceway are made integral with the concrete wall facing the rock cut. The main channel, through which the boats are to pass, is narrowed down to 50 ft. at the dam by a heavy pier placed about 17 ft. off center in the canal, leaving a sluiceway on the other side of the pier of 20 ft. Extending from each end of the pier to the side walls are by-pass arches under which the water may flow through the sluiceway, but which prevent the passage of boats. Mounted on the extended side walls and the middle pier is a framework over the main channel, on which is hung a gate, which is dropped down between guides across the channel, completely stopping the flow. Over the sluiceway channel is another framework carrying a segmental gate, which can be turned down into the sluiceway to stop that completely when necessary. Thus the flow may be diverted to either channel, or shut off completely, as desired.

The masonry is of simple design, easily understood from the drawings (Fig. 3). The foundations are all on solid rock so that no difficulty was encountered in their design. In most places the concrete is all plain mass work, either founded directly in the rock, or forming a facing to it, but in one or two cases, reinforcement has been added as an additional precaution, notably in the curtain wall across the sluiceway and in the by-pass arches. The curtain wall, as shown in Figs. 1 and 8, extends across the sluiceway to act as the upper closing wall against which the radial sluiceway gate abuts. It is reinforced as shown in Fig. 3. The by-pass arches are not reinforced against vertical loads, as is common in bridge arches, but are reinforced on their inner faces against the impact of boats. It will be noted that the piers for these arches are spread toward the sluiceway at the bottom. Reinforcing rods are also placed running horizontally along the facing wall on the shore side of the main channel, where the guard gate engages the wall. This is to provide additional strength against the shearing stresses caused by water pressure against the gate.

Sills, against which the gates abut, are provided across both channels, by placing concrete in grooves dug in the solid rock.

The details of the main gate are shown in Figs. 4-6. It consists fundamentally of towers on either side of the channel, carrying a cross frame on their top, and provided with guides in which moves the vertical gate, which is hung from the cross-frame. The guides for the gate are channels riveted to the inner faces of the towers and extending for a few feet down into the groove in the concrete side walls. The gate, as shown in Fig. 6, is a series of horizontally placed plate-girders, carrying an outer skin of ⅜-in. plate. At its top there is on either side an extended plate cut to fit, with ½-in. clearance, the channel guides, and this serves to keep the gate in position during raising and lowering. It travels in the masonry groove on six cast-iron wheels, arranged as shown in the drawings, and bearing against a cast-steel track bolted to the face of the groove. This does not make an absolutely tight dam, but it is tight enough for the purpose.

The gate is hung by a multiple-rope passing over sheaves in the overhead bridge and controlled by either an electric-motor or hand drive. A concrete counterweight, not detailed in the accompanying drawings, but traveling inside the tower on a specially arranged track, aids the mechanical drive.

The sluiceway gate is shown in Figs. 7-8. It consists of a segmental gate hung upon bearings resting on the concrete of the pier and of the side wall, and operated by a hand-driven rack from a crank on the middle pier. The gate proper is hung on tapered axles, of 9½-in. maximum diameter, and consists of two straight girder arms carrying on their ends, two segmental girders which form the backing for the dam proper, a skin of ⅜-in. plate on transverse 9-in. I-beams. At the upper end this fits against a projecting horizontal built-up girder attached to the lower end of the curtain beam; at the lower end it is provided with a timber butting block which foots against the concrete sill in the sluiceway bottom. The trunnion bearings are fastened, each to a vertical steel girder embedded in the concrete of the piers. The counterweight consists of a concrete block extending for the whole width of the sluiceway and attached to the main girders of the gate by a pin connection to extending pin-plates. It is held in a vertical position under all positions of the gate by a link connection to the vertical embedded girders.

The gate is hand driven from the rack shown on Fig. 7. The drive for this rack is mounted on the middle pier and is connected to the gate

FIG. 2. VIEW OF DAM DURING CONSTRUCTION.

by a worm gear and shaft extending out to a pinion mounted on face of the curtain wall, engaging there a rack mounted on a frame extending from the segmental skin, in line with the nearest of the main radial girders. Normally this gate is up, allowing water to pass under, and even when the main gate is opened to allow boats to pass there will be no need for closing the sluiceway. Only in the emergency of requiring the entire canal to be shut off will the segmental gate be closed.

It is intended in the future to build a bridge over the whole canal at this point, but such bridge is not shown in the accompanying drawings.

The dam was designed under the direction of Mr. W. R. Davis, Assoc. M. Am. Soc. C. E., Chief Bridge Designer and Inspector, under the general supervision of Mr. William B. Landreth, M. Am. Soc. C. E., up till recently the Deputy State Engineer. It is being built by the Penn Bridge Co., Beaver Falls, Pa. At the present time erection is nearing completion under the present officials, Mr. John A. Bensel, M. Am. Soc. C. E., State Engineer and Surveyor, and Mr. Alexander E. Kastl, M. Am. Soc. C. E., Special Deputy Engineer in Charge of Barge Canal.

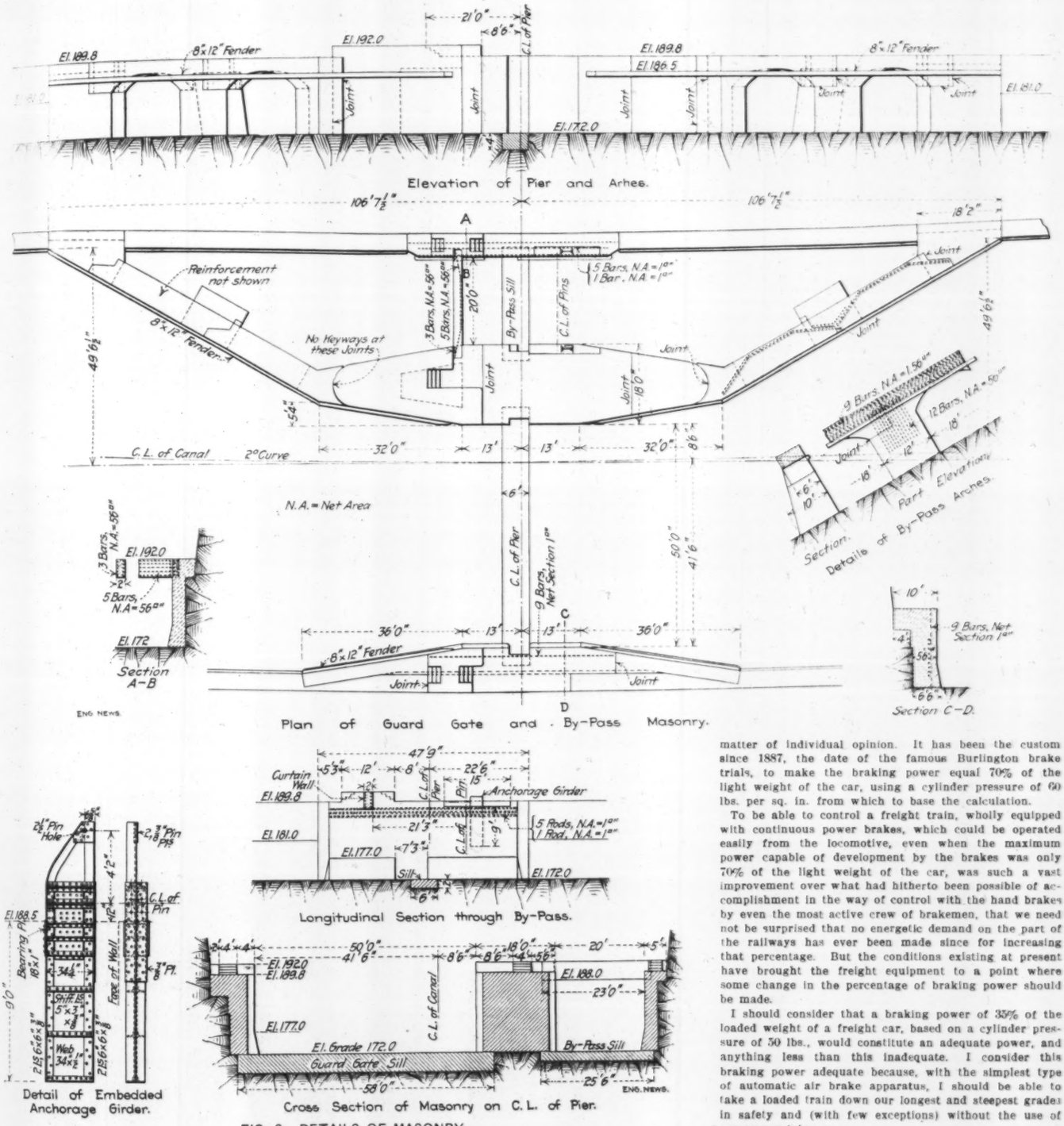


FIG. 3. DETAILS OF MASONRY.

A MECHANICAL CEMENT SHAKER-SIEVE has been rigged up at the testing laboratory of the Intercepting Sewer Board, Syracuse, N. Y., from an old sewing machine so connected as to transmit a reciprocating motion to the shaker tray. The machine is driven by a belt from a small water motor connected to a nearby water tap. It is so arranged that both a rotating and an up-and-down motion are given to the tray.

Increased Braking Power for Freight Cars.*

By JOHN P. KELLY.†

Ever since continuous power brakes have been employed to control the motion of freight trains, the amount of braking power that should be used has been much a matter of individual opinion. It has been the custom since 1887, the date of the famous Burlington brake trials, to make the braking power equal 70% of the light weight of the car, using a cylinder pressure of 60 lbs. per sq. in. from which to base the calculation.

To be able to control a freight train, wholly equipped with continuous power brakes, which could be operated easily from the locomotive, even when the maximum power capable of development by the brakes was only 70% of the light weight of the car, was such a vast improvement over what had hitherto been possible of accomplishment in the way of control with the hand brakes by even the most active crew of brakemen, that we need not be surprised that no energetic demand on the part of the railways has ever been made since for increasing that percentage. But the conditions existing at present have brought the freight equipment to a point where some change in the percentage of braking power should be made.

I should consider that a braking power of 35% of the loaded weight of a freight car, based on a cylinder pressure of 50 lbs., would constitute an adequate power, and anything less than this inadequate. I consider this braking power adequate because, with the simplest type of automatic air brake apparatus, I should be able to take a loaded train down our longest and steepest grades in safety and (with few exceptions) without the use of pressure retainers.

Up to comparatively recent years the chief consideration for the limitations on the percentage of brake power that should be employed on freight cars has been that of the supposed danger to the wheels from sliding flat, rates of retardation in different parts of the train and the shocks resulting therefrom not being considered, probably for the reason that with the shorter trains the effects of these were not so pronounced and therefore not so likely to be noticed as they are to-day in our much longer trains.

Few who are familiar with this phase of the question now believe the wheels are in any danger from sliding

*Abstract of a paper read at the annual meeting of the Air Brake Association, at Chicago, May 23, 26.

†Road Supervisor of Air Brakes, Nashville, Chattanooga & St. Louis Ry.

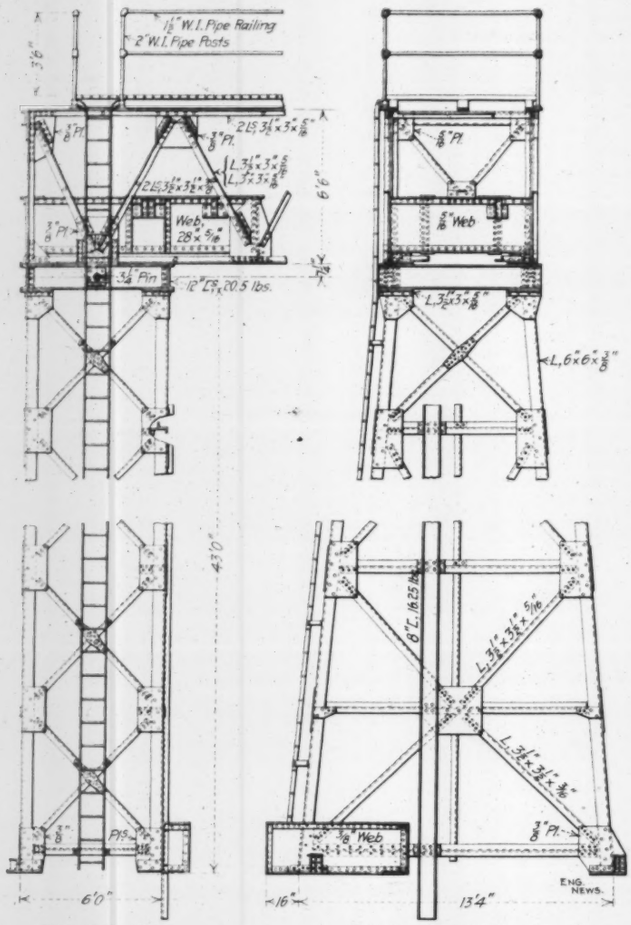


FIG. 4. DETAILS OF EMERGENCY DAM TOWER FRAMING.

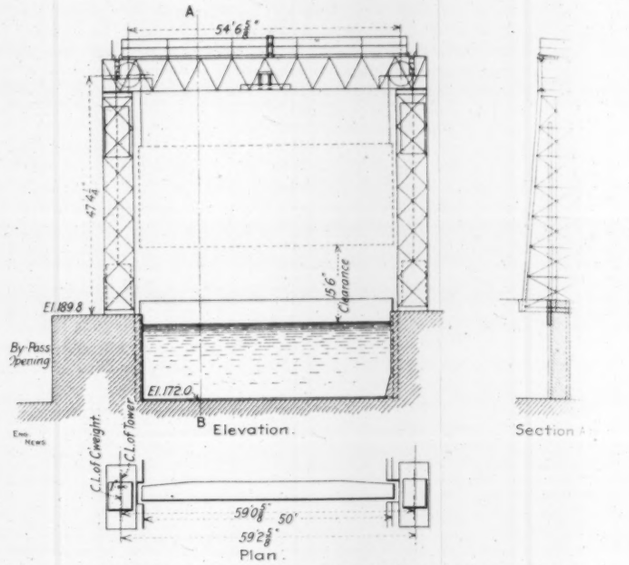
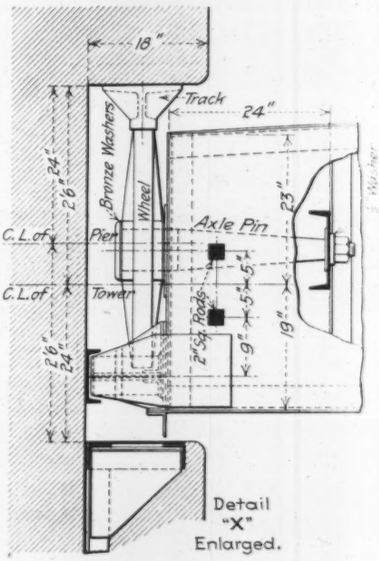


FIG. 5. GENERAL OUTLINE OF EMERGENCY DAM ACROSS MAIN CHANNEL.

flat, due to the braking pressure alone, however much may be applied to them, if all the wheels in the train are impressed with the proper amount of shoe pressure. Pressure alone cannot cause them to slide flat, but numerous other conditions which tend to produce wheel sliding must be present and active to cause them to slide while being acted upon by the brakes. Again, the length of the flat spot produced on the sliding wheel is in turn dependent on the weight that the wheel is carrying at the time, the condition of the rail (whether wet, dry or sandy), and somewhat on the kind of metal in the wheel, as well as largely on the inequality of distribution of braking power in the whole train.

Therefore, I do not anticipate any very decided opposition to my plea for an increase in the percentage of braking power now generally employed on freight cars to something quite beyond what some of us may deem practical, on the ground of any fear of what may happen to the wheels. But to my mind the objections that will be raised will come from a serious consideration of what effect a braking power of 120% of the light weight of each car (about 35% loaded weight) would have in a train of 100 or more cars, all braking at this percentage, when they were wholly loaded or wholly un-



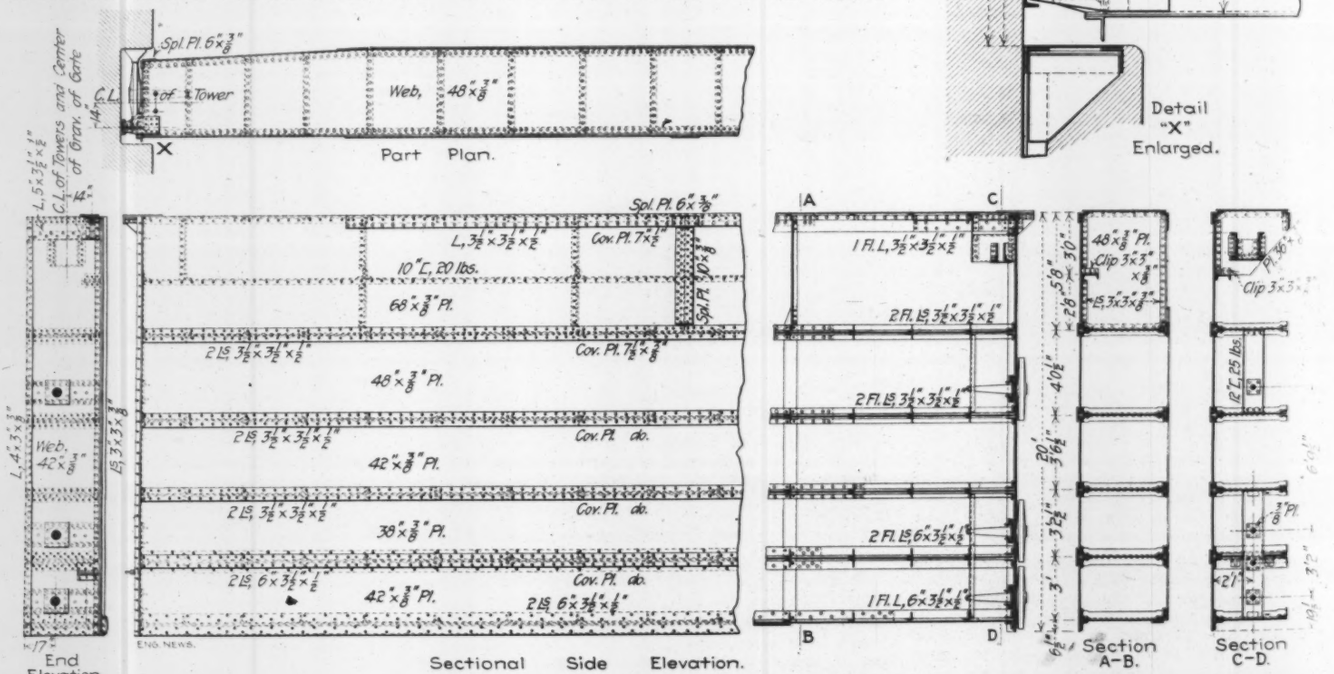


FIG. 6. DETAILS OF GATES TO EMERGENCY DAM.

loaded, part loads and part empties, whether running at 10 or at 40 m. p. h., with either a service or an emergency application.

When brakes are applied on a long train, whether in service or in emergency, some shock of more or less severity as a general thing results on the rear. Even when no brakes are applied and a very long train is drawing into a curve, the resistance produced by the curve on the forward portion of the train is sufficient to cause well pronounced shocks at the rear; it may be severe as it sometimes is, or it may be extremely severe. However, whether the shock be light or heavy, our long trains are subject to another danger coming from what we term the "internal pressure" which acts during the progress of an application of the brakes either in a service or in an emergency, and which becomes sometimes great enough to cause the train to buckle and force the car upon which the enormous pressure acts to move out sideways from the track.

The buckling of our long trains is a serious matter, even now while we are using only 70% braking power, although as equipment of steel construction increases this danger diminishes. But any change that we are to consider, either in braking power employed or method of handling the brakes, must be with a view always to lessening the chance for damage in effecting stops. In short, it should be possible for the brakes to apply from any cause, either in service or in emergency, without danger of heavy shock or damage.

Even with the automatic coupler there yet remains considerable slack in our long trains that makes itself felt more or less strenuously whenever the brakes are applied in emergency, so that, while we desire to give full credit to the air brake for all that it does, yet it is only fair to the coupler to give it credit for making possible the degree of success thus far attained by the air brake in operating without destructive shocks. But the amount of slack is yet so great that it must be considered in connection with any scheme of braking that may be proposed.

How are we to increase our braking power without at the same time increasing the danger of shock under all conditions of train make-up? To answer this question fully would require considerable space, but we may say that with every considerable increase made in the percentage of brake power employed we immediately reduce the probable number of emergency applications that will be required, and this in itself is a very great gain.

The consideration of the lessening of the time to complete a stop where the higher braking power is employed will, I am sure, lead to the conclusion that it can be successfully employed on trains that are composed entirely of empty cars or on trains composed partly of loaded and partly of empty cars, while as to its successful operation on trains composed entirely of loaded cars it seems to me there can hardly be any question.

With all things in good condition, a fairly short stop may be made in emergency on level grade with the present 70% of the light weight. But even here we find conditions such in fast freight service that a more powerful brake is very desirable. In fact, where such fast freight trains are run on a fast schedule and following passenger trains, the brake should be powerful enough to stop them in distances equally short from the speed at which they are run as passenger trains can be stopped from their average higher speeds.

When an emergency arises due to carelessness or oversight on the part of the engineman in charge of the freight train in observing signals, or in case of short flagging on the part of the flagman on a preceding train, a quick and powerful brake can save a lot of trouble and, in many cases, life as well as property.

But when we come to consider heavy grade work where trains of heavy capacity cars are handled, and these with the usual 10% overload, the higher braking power will be of great advantage. On a 4% grade the proportion of the total weight tending to accelerate motion down the grade is 4% of the load or total weight of the car. Taking a car whose total weight is 150,000 lbs., the accelerating force is 6,000 lbs., and to neutralize this force a retarding force of 6,000 lbs. must be exerted. Where the total brake force on such a car is but 70% of the light weight, (based on a 60-lb. cylinder pressure, the car weighing 40,000 lbs.), we have a total brake force of 28,000 lbs., and from this force we can count on from 15 to 18% of it as the retarding force, or from 5,200 to 4,640 lbs. I have not considered resistance due to flange, journal and curves, friction nor losses in braking power chargeable to the foundation gear.

Evidently here is a case where we must have more retarding power if we are to control the motion of the car, for the force of gravity equals 6,000 lbs., and the braking power or retarding power must be greater than this to control the motion.

Taking the braking power at 120% of the light weight, or 48,000 lbs., we should then have a retarding power of from 7,200 lbs. to 8,640 lbs. In addition to this, if we increase the brake pipe and reservoir pressure from 70 to 90 or 100 lbs., we have a brake which is capable of handling the train safely with a reasonable margin of safety on a grade of 4%. On all lesser grades, unless they were very long, it would be quite possible to handle trains on them without the aid of pressure-retaining valves. This would be very desirable for several reasons, among them the avoidance of the necessity for trainmen to go over the train to operate them and the prevention of the slid flat and hot wheels that are chargeable to their use.

We have now mentioned some of the advantages to be derived in freight service from an increase to 120% braking power, or better, to 35% of the loaded weight. But would not this cause some terrific shocks on the 100-car train on level grades? I do not think so, and for the following very good reasons: The shock and internal pressure which causes buckling is not due so much to the amount of braking power as to the manner and time in which it acts. I should expect the higher braking power to accomplish a much smoother stop so far as shock in the rear is concerned. In an emergency application on a train of empty cars, would not the braking power be so heavy as to slide and flatten all wheels? I should say there will be no flat wheels; whether any will slide or not will depend on how fast the train is going at the time the application is made, and in this case it should be borne in mind that unless the speed is very high the cause for the emergency will have to be very close and sudden, else a service application, with the high braking power, will suffice to bring the train to a stop. In any case, however, there will be no slid flat wheels, as the empty car does not impress sufficient weight on the wheel to cause it to flatten, unless slid several thousand feet.

But how about the mixed load and empty train, say consisting of about 35 loads and 65 empties, will they break in two when the brakes are applied either in service or emergency application? And I answer "No," for good and sufficient reasons.

It is my belief, however, that if the higher braking power for freight cars should receive any attention the time of equalization between the auxiliaries and the brake cylinders should be increased so as to permit the rear brake on a 100-car train to commence to apply before the first brake is fully applied. This would increase the flexibility of the brakes both in service and in emergency applications, and no heavier brake gear would be needed to be employed than is now the case with the 70% brake.

We find cars now running that are braked at nearly 100% of their light weight, based on 60 lbs. cylinder pressure, and these are mixed in trains with other cars braking as low as 60% and having ordinary quick action triples. Yet these conditions are being got along with fairly well. How much better, then, would matters be if the loaded weight of the car was used as the base on which to fix the braking power, if the percentage determined upon were 35% or more, as experiment might show could be successfully used.

With braking power of the percentage given, based as recommended above, a proper regulation of the flow of air into the brake cylinder, as well as quick serial reduction in brake pipe pressure, will in my judgment improve conditions in freight service to such extent that runaways on grades will never be heard of again, and shock and break-in-two on our long trains will almost, if not entirely, disappear, while many of the cases now requiring an emergency application to stop in time to prevent accident will then require only a service application.

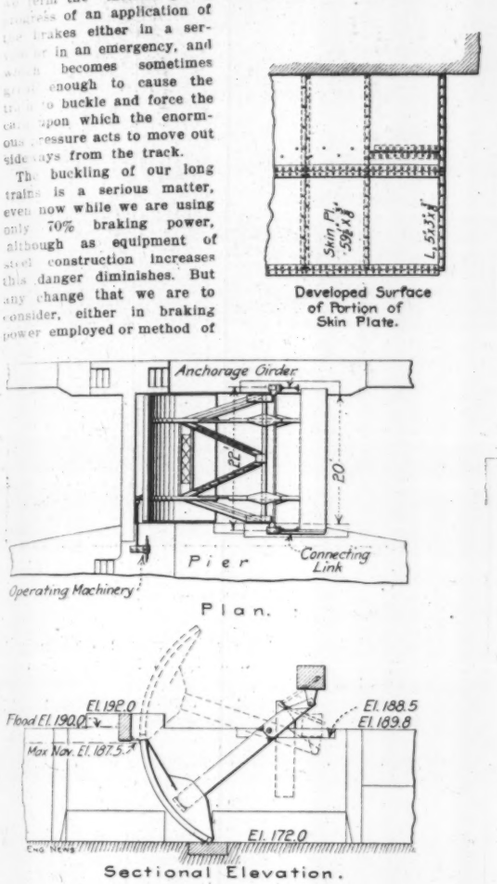


Fig. 7. General Outline of Sluiceway Gate.

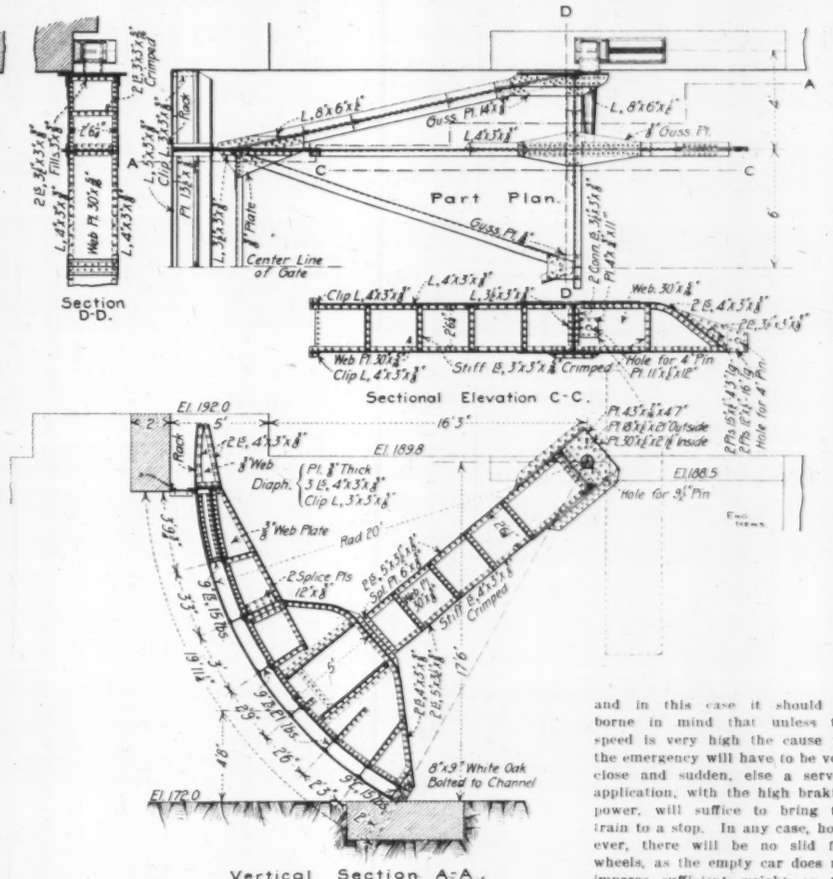


FIG. 8. DETAILS OF SLUICEWAY GATE.

Cornelius Gap Tunnel of the United Railways Co., Near Portland, Oregon.

By W. P. HARDESTY,* C. E.

The United Railways Co. was organized to build an electric railway line westward from Portland, Oregon, by the shortest practicable route to the Pacific Ocean, the terminus to be at Bay City, on Tillamook Bay, due west from Portland, making a length of 78 miles. The route is over a rough country, crossing several ranges of hills or low mountains; many high trestles and several tunnels are required.

From Portland the line runs northwesterly down the Willamette River for 13 miles, when

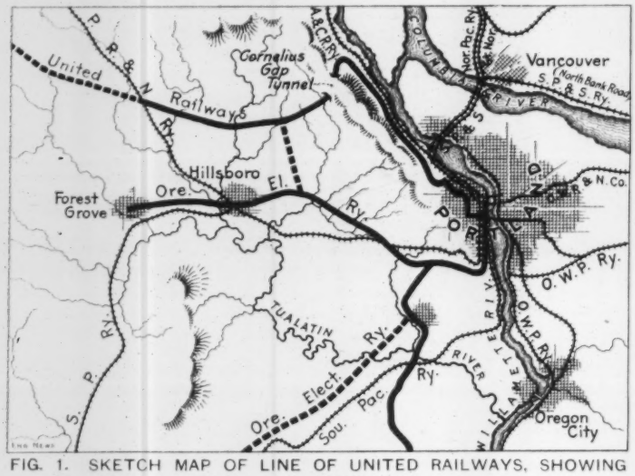


FIG. 1. SKETCH MAP OF LINE OF UNITED RAILWAYS, SHOWING CORNELIUS GAP TUNNEL.

it turns westerly and southwesterly and in three miles more reaches the summit between the Willamette Valley and the smaller Tualatin Valley. Through the divide here, known as Cornelius Gap, a tunnel has lately been built, by which the maximum grade on the east side is kept down to 1.5%, and that on the west side to 1.0%, compensated. The railway crosses Holbrook Canyon at the east end of the tunnel with a trestle 105 ft. high and about 500 ft. long, and crosses Rock Creek Canyon at the west end with a trestle 120 ft. high and over 1,100 ft. long. A descent of about 100 ft. is then made in the Tualatin Valley, about 20 miles across, when the ascent of the Coast Range begins. At Mile 44 a tunnel over a mile long will start through the range, the elevation thus being kept down to 1,200 ft. above sea level, beyond which the road will descend the valley of Wilson River to the ocean. Over the Coast Range there will be grades of 2.5% westbound and 1.8% eastbound, requiring the use of helper engines. Nearly all the heavy freight traffic will be eastbound. The maximum curvature on the entire line is 4°.

The Cornelius Gap Tunnel is one of the longest so far built for an electric railway, and it is an interesting piece of work. The length is 4,103 ft. About 300 ft. of the east end is taken up by a 4° curve and its spiral, which required extra care in the alinement work. There is a descending grade of 0.2% each way from its summit, at elevation 379.

Work was first started by the railway company by day labor. In the spring of 1910 the road was absorbed by the Hill interests, and work on a much larger scale and under new plans was soon started. The contract for building the tunnel was let to Porter Bros., well-known railway contractors of Spokane, Washington.

The tunnel runs through a solid basalt rock formation for practically its whole length. The heading was first driven, full size, followed at a distance of 150 to 200 ft. by excavation of the bench. There were used two different standard plans for the tunnel, according to the material encountered, both using timbering.

One plan gives 17 ft. 4 ins. in width between timbers and a height of 22½ ft. above top of tie. All timbers are 12 × 12-in. The posts rest on sills and support wall plates, on which rests the five-segment arch. The timber sets are spaced 4-ft. centers. The lagging used back of the timbers was 4 × 6 in. and the overbreak back of the lagging was filled with cordwood and slabwood. This section was used in ground where the timbers may be removed during lining. The lining will be concrete, and it will leave a net section 16 ft. wide, and with a center height of 22½ ft. above tops of ties.

In the second plan of timbering, used in ground where the timbers are non-removable during the lining, the clear width between timbers is 18 ft. 8 ins., which allows a minimum thickness of wall-lining of 16 ins. An allowance in height is also made so as to provide 8 or 10 ins. thickness of lining under the top segment. A length of only 103 lin. ft. of tunnel was lined with timbering of this arrangement. In this the spacing of timbers was 3 ft.

In the first plan the necessary excavation per lineal ft. is 17.9 cu. yds.; in the second one it is 19.6 cu. yds.

The basaltic rock was of a varying structure, some of it very hard and breaking long and splintery, while another and softer kind broke "short" and was thus much more easily kept in its section. The lighter, scoria-like rock broke much closer than the dense kind, but gave trouble in drilling because of tendency of the drill to deflect into the gas holes. The close-grained rock required very frequent sharpening of drills. For all of the tunnel timbered on the first plan the rock stood temporarily very well without timbering. No cave-ins ever occurred.

Porter Bros. began work on the tunnel in May, 1910. There had already been driven 281 ft. at the west end and 153 ft. at the east end. The work has since been prosecuted under direct charge of Porter & Clarkson, sub-contractors. A very efficient organization was developed, and the uniformity of progress has been something remarkable. For the six months of August, 1910, to January, 1911, inclusive, the progress in the two headings ranged from 305 ft. to 484 ft., while that of the bench ranged from 423 ft. to 536 ft.

WORK AT WEST END.—About two-thirds of the total distance was driven from the west [illegible] where the average and the maximum monthly progress for the months August to January, inclusive, in the heading were 316 ft. and [illegible] respectively; for the bench these figures were [illegible] ft. and 385 ft., while the minimum for the [illegible]

Fig. 3. Air-Operated Shovel Loading Bench Muck In West End of Cornelius Gap Tunnel, United Railways Co.

was 300 ft. For the class of ground to be moved, the record of 385 ft. of bench is believed to be unequaled.

There were worked two 10-hour shifts in the heading, a full crew being about 27 men, while on the bench were worked "call" shifts, as follows: A shift of drillers and one of shovel men or muckers. Before the drillers shot the bench a call boy would awake or notify the members of the shovel crew, who would enter the tunnel immediately after the smoke had cleared. After removing the muck they would be succeeded in turn by the drillers, called in the same way. The use of "call-shifts" is believed to be an inno[illegible]

FIG. 2. WEST PORTAL OF CORNELIUS GAP TUNNEL, SHOWING POWER-PLANT.

*60 East 31st St., N., Portland, Ore.

FIG. 4. VIEW IN HEADING OF CORNELIUS GAP TUNNEL, SHOWING FIVE-SEGMENT ROOF TIMBERING AND 2-FT. GAGE TRAMWAY.

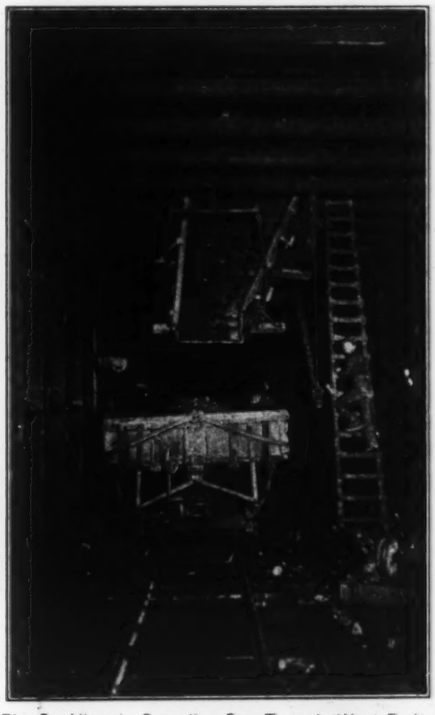


Fig. 5. View in Cornelius Gap Tunnel (West End), Showing Suspended Chute for Dumping Heading Muck Into Cars on Floor Track.

vation in this class of work. These shifts were usually short, but the men got full time for them, and in one month the call shift men put in 48 shifts. It was really piece work, as there was a certain amount of work to do each shift, and the men had an incentive to make quick time. This arrangement was satisfactory all around, as the men got well paid for their work although having no regularity in their rest, while it enabled the contractors to keep work going in the tunnel every hour of the 24.

Air drills were used for drilling, four each in the heading and on the bench. The muck was loaded by a steam shovel of about 40-ton size, with which was used a dipper of about 1/3 cu. yd. size. The shovel was fitted so as to be operated by compressed air, and it loaded the cars very rapidly. For hauling out muck a 3-ft. gage tramway was used on which were operated electric trains, three 4-yd. cars being hauled out by a mining locomotive. For hauling muck out of the heading, a 2-ft. gage tramway was laid on overhead cross-pieces resting on the wall-plates. The loaded cars were pushed over this by hand and dumped by a suspended inclined chute into the main cars below.

An I-beam rail was temporarily lag-screwed to the bottom of the middle segments of the timber arch, on whose flanges ran a double wheel, forming a small traveling crane. This was used to carry timbers back into the heading, or to deliver them to a car to be taken back. A differential pulley was used to hoist timbers from below, it being hung to the top segment of the arch by hooks. The timbering in the heading, i. e., the wall-plates and arches, was placed by a part of the heading gang. The timbers were supplied to them over the overhead tramway by a "swing" shift, whose work was all-around, bringing timbers into the tunnel, keeping up track, etc.

The contractors were paid by the lineal foot for the net section of tunnel, 16 × 24 ft., while the necessary excavation outside of that was paid for by the cubic yard. The over-break back of the lagging was not paid for unless it was absolutely unavoidable. A very clean section with but little over-break was made, notwithstanding that the formation was unfavorable to it. The timbering was paid for by the thousand feet B.M. in place, while the cord-wood and slab-wood backfilling was paid for by the cord.

An unsually substantial plant was installed at the west end of the tunnel for carrying on the work. In the power house were the compressor and electrical machinery. All machinery was operated by electrical power, the current being taken from the transmission line that supplied the railway itself. Power was thus brought from Portland at 10,000 volts, it being stepped down by two banks of three transformers each to 440 volts. Current was furnished to incandescent

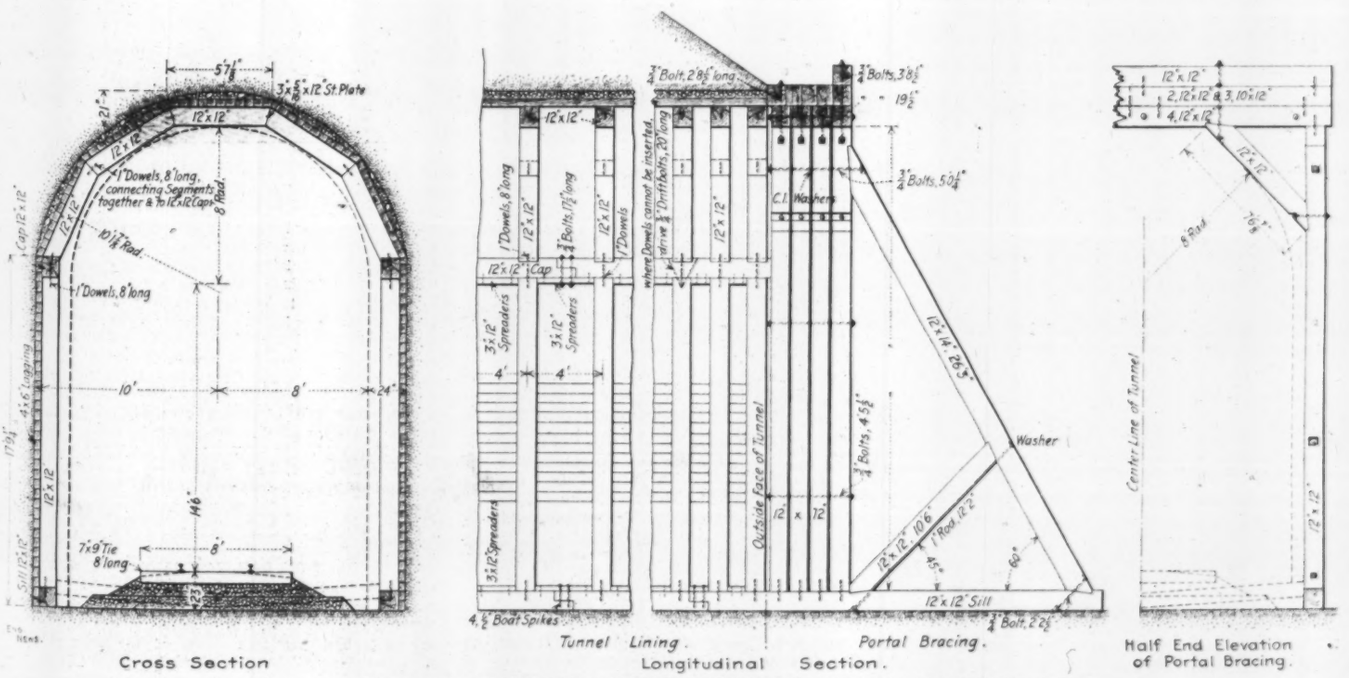


FIG. 6. TYPE DRAWING OF TIMBERING FOR CORNELIUS GAP TUNNEL; REMOVABLE TYPE.

lamps for lighting the tunnel. There were used one 200-HP. and two 100-HP. motors for driving the compressors and steam shovel, and one motor-generator set of 100 HP. for operation of the tunnel tramway, furnishing direct current at 500 volts. One 75-HP. motor was used to drive the exhaust fan for the tunnel, the ventilation of the tunnel consisting of the supply of fresh air by the air drills and the suction by the fan.

There were used two 14 × 16-in. compressors, and one two-stage 16¼ × 25¼ × 16-in. compressor with capacity of 1,225 cu. ft. per min., all with 90 to 100 lbs. pressure. A 20-HP. motor served for pumping the water used. All machines were mounted on concrete foundations.

The blacksmith shop used compressed air for the operation of three forges, for a drill-sharpening machine, a power-hammer, etc. The sawmill plant used electric power in sawing and fitting timbers for the tunnel.

WORK AT THE EAST END.—The work at the east end was done partly by hand. Air for driving drills was furnished by a pipe brought over the hill from the west end. The mucking was all done by hand, and horse tram cars were used.

The headings of the tunnel met on Feb. 12, 1911. On Feb. 24 the bench was completed, there being

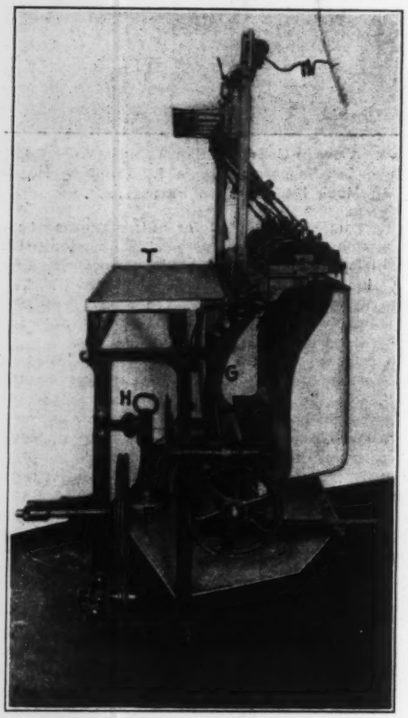


Fig. 2. Blue Printing Machine Showing Adjustable Friction Drive.

336 ft. of bench excavated in the 23 days in February.

During the building of the tunnel a temporary line was operated over Cornelius Gap, by which supplies could be taken to the west end. This line had grades as steep as 5.0% on the west side, and curves as sharp as 28°. The summit is about at el. 600. The railway is now operated to Banks, 28 miles from Portland, and work is in progress across the Tualatin Valley.

The building of the tunnel was carried out under the immediate supervision of Mr. Wm. Mayer, assistant engineer for the United Railways Co. Mr. Mayer has had an extensive experience of this kind, this being the 17th tunnel with which he has been connected. The chief engineer of the United Railways Co. is Mr. L. B. Wickersham.

To the gentlemen who have been named the writer is indebted for data from which this article has been prepared.

A New Electric Blue Printing Machine.

A new blue printing machine combined with a washing and drying apparatus, and embodying several novel features, has recently been placed on the market. It consists essentially of two separate machines as shown in Fig. 1. The machine on the right is an electric printing apparatus (Fig. 2) and the one on the left an automatic washing and drying machine. The whole is operated by the ¼-HP. electric motor shown in the right-hand corner of Fig. 1. Both machines are built of sheet metal, no wood being used.

For making ordinary blue prints, the tracings and paper are fed into the printing machine at the table T, Fig. 1 and 2, and are carried down over the convex side of a curved plate of glass G, Fig. 2, by a continuous band or belt of canvas. Facing this glass is a series of electric arc or mercury vapor lamps. The speed of the belt can be regulated to the needs of any particular paper by raising or lowering the friction drive wheel F by means of the handle and set screw H, as is plainly shown in Fig. 2.

After being exposed the tracings are retained in the conical shaped box below the arc lamps (Fig. 1), while the exposed paper passes under the box and the platform P and over the roller R. When below the hood C, a constant stream of water, coming from the spray-pipe D and deflected over the outside of C, flows over the entire width of the print. The paper is then carried, face outwards, under the hood C and is rewashed in passing under the spray-pipe D. In passing beyond this pipe the surplus water is scraped off and the print is carried up in front and over the heated pipes S, coming down on the opposite side to E, perfectly dried and finished. At E the paper automatically rolls itself up by resting on continuous canvas belts or is run on a table and cut up into individual sheets, as may be desired.

If it is desired to give the prints a deep purple-blue background with pure white lines, a bichromate of potash solution can be automatically applied. The tank A, Fig. 1, is for this purpose. The bichromate solution in this tank is pumped by a small centrifugal pump, driven by the motor shown in the cut, from the tank to a spray-pipe behind the hood C, which has at the bottom a narrow U-shaped tank.

After the first washing, the water is scraped off as the paper passes behind the hood C. The paper then receives a bath of the bichromate solution, which is in turn scraped off, as the paper emerges at the top of C, and is carried down on the inside of C, collected in the tank in the U-bottom, and returned to the tank A. The paper then receives another washing by passing under the spray-pipe D, and then over the dryer pipes as explained before. These pipes are heated either by gas or electricity.

The process for making Vandyke or black-print negatives is exactly the same as that just described for blue prints, using, of course, the necessary chemical solution.

The whole operation is continuous and automatic. Having fed in the tracings and the blue print paper, which is placed in a roll under the table T, nothing remains for the operator or assistant to do but to remove the finished roll of prints at the farther end of the machine. The tracings are quickly removed from the box and can easily be fed again into the ing machine if additional prints are requi

This machine is made by Williams, Br & Earl, Inc., of Philadelphia, Pa., and is c ed by them to have a capacity of 360 lin. ft 42-in. width of paper, or 1,260 sq. ft. of fi ed prints per hr. With the cost of electricity in Philadelphia, they estimate the cost of op on per hr. as follows:

Electricity	$0.35
Carbons and Potash	1
Blue Print Paper	4.80
Labor	25
Total	$5.41

This gives an average of about ½-ct. p sq. ft. of finished print. The machine is also ade to take a 52-in. width of paper.

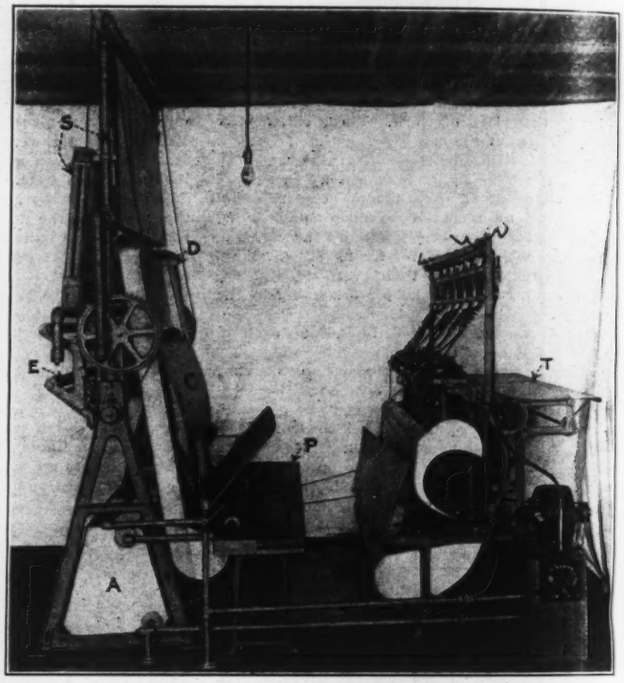


FIG. 1. EXPRESS BLUE PRINTING, WASHING AND DRYING MACHINE MADE BY WILLIAMS, BROWN & EARLE, PHILADELPHIA, PA.

BOILER, ELEVATOR AND FLYWHEEL ACCIDENTS during the month of March in the United Stat and Canada, as listed by the Fidelity & Casualty Co., of New York, killed a total of 48 persons. This is about the average for the preceding six months. Boiler explosions in March killed 22 persons, not including a number reported "fatally injured." The number of explosion was 28. The most fatal was that at Estacada, Ore., March 4, which killed seven men. (Eng. News, March 16, 1911, p. 337.) This was the only single explosion in which more than three persons were killed. There were 79 elevator accidents during the month, in which a total of 23 persons was killed. Of these, 8 fell down shafts, 7 were caught and crushed and 8 were killed by falling elevators. The most fatal accident was at St. Paul, Minn., March 14, when a car fell and killed four persons. Ten flywheel accidents were listed for the month, only one of which resulted fatally. This was in the plant of the Mimegus Steel Co. at Pueblo, Colo., March 17, when three men were killed and nine others injured. Of the ten "flywheel" accidents, three were grinding-wheel explosions and two involved rotary saws.

AXLE LOADS ON RAILWAY CARS was investigated by the Committee on Brake-Shoe Equipment of the Master Car Builders' Association and reported on at the recent convention of that association. It was found that an eight-wheel passenger coach of the Pennsylvania R. R. weighing 119,000 lbs. gives the heaviest load per wheel of any car in this country, viz., 14,875 lbs.

The Nature and Characteristic Components of "Permissible" Explosives.*

By CLARENCE HALL.†

TESTS OF EXPLOSIVES.—From Sept. 2, 1908, to June 1, 1911, during which time the gallery for testing explosives has been in operation in Pittsburg, Pa., 143 explosives have been submitted for official tests, 84 of which have passed all test requirements of the Bureau of Mines and are considered permissible for use in coal mines under certain provisions. The remainder have either failed to pass the test or have been withdrawn by the manufacturers when introducing new and improved explosives.

During the year 1909, 8,598,027 lbs. of permissible explosives were used in the United States. In the mines of Great Britain there were used, during the same year, 8,502,272 lbs. of permitted explosives. For the year 1910 the use of permissible explosives has shown a marked increase in the coal mines of this country. The returns received from the manufacturers indicate that the quantity used during the year 1910 will reach 12,000,000 lbs.

The underlying reasons why one explosive passes and another fails when tested in the presence of gas and dust have been investigated at the testing station. The results of researches made, especially on explosives which failed to pass tests, have been reported to the manufacturers and in nearly all cases resulted in the manufacturers so changing and perfecting their explosives that later when new explosives were submitted, they have successfully passed all requirements of the Bureau. The results of tests indicate that every explosive, if fired in very large quantities, will cause ignition of gas and coal-dust mixtures. An arbitrary charge; namely, 1½ lbs., has been established as the amount of explosive to be used in making tests and all explosives in order to be placed on the permissible list must pass the gas and dust test with this charge of explosive. A charge of 1½ lbs. per drill hole could never be exceeded in practice. In good mining practice it need not exceed 1 lb. and, accordingly, a greater factor of safety obtains.

Explosives of many different compositions are now on the permissible list, but all have been formulated with a view to producing explosives which on detonation give a relatively low flame temperature of short duration. It has been found that in order to ignite inflammable gas and coal dust mixtures a certain temperature, acting through a certain length of time, is required. It has also been determined that the temperature, on detonation, of all explosives exceeds the ignition temperature of inflammable gas and dust mixtures, but fortunately the flame of the permissible explosives is of such short duration, when properly detonated, that the requisite time necessary for igniting the inflammable mixtures does not obtain.

It is evident that any factor that increases the duration of the flame temperature of a permissible explosive, such as the use of a weak detonator, or the use of any explosive not in accordance with the provisions prescribed by the Bureau of Mines, will increase the danger in their use.

The energy developed by the detonation of permissible explosives, like other high explosives, depends on the change of the small solid particles and liquids of the explosive into larger volumes of gases and the rate of detonation or the rapidity with which these gases are formed. To meet the varying coal-mining conditions in this country the manufacturers have formulated explosives varying in rate of detonation from 4,746 to 14,560 ft. (1,447 to 4,439 meters) per second.

It is evident that for certain work where a shattering effect is desired in driving through or bushing rock, or for producing coal for coking purposes, the explosive reaction should be rapid, and permissible explosives should be selected having a high rate of detonation. In a similar manner a suitable permissible explosive for use in soft friable coal and especially so when lump or steam coal is desired, should be selected which develops its gases at a slow rate in order that the pressure developed will be more prolonged.

I have been informed that the coal operators of West Virginia are overwhelmed by agents of permissible-explosive makers with their various claims of efficiency. To establish their claims it means that their demonstrators must conduct a series of experiments over a considerable period of time in the mines. This procedure should not be discouraged, for the reason that the manufacturers are constantly improving their explosives and in many cases permissible explosives which are more suitable to the work have been selected as a result of such tests. However, much of this unnecessary work could be eliminated by careful consideration of the physical characteristics of each explosive before making tests. The chemical composition would be of little value to the operator and it is not proposed to publish such information. In several instances, in mining bituminous coal, it has been found that permissible explosives containing only 20% of nitroglycerin have given better results and produced better coal than those made under a similar formula containing 25% of nitroglycerin. The physical tests of explosives, such as in the U. S. Gallery of rate of detonation, strengths of explosives as determined by lead blocks, gages, ballistic pendulum, height and duration of flame, will be published as Bulletin No. 15 by the U. S. Bureau of Mines during the present month. This information will be of value to both the manufacturers and users of explosives.

Suppose, for instance, an operator has tried several permissible explosives in a certain mine where the coal is soft and friable and has selected one as the most suitable for the work in question. From this bulletin he will note that the rate of detonation of this explosive is 2,000 meters per second. Now suppose the operator receives a request to try out a new explosive. He should first ascertain the physical characteristics of the new explosive. If he learns that the new explosive has a rate of detonation of 4,000 meters per second it would be obvious that this explosive would be too quick in action and not suitable for this particular coal. It is true a powder man skilled in the use of a quick explosive might possibly in a limited series of tests, through special skill, demonstrate the new explosive to be more economical and at the same time equally efficient as a slower permissible explosive, but it should not be expected that the average miner would obtain the same results.

USE OF EXPLOSIVES.—By carefully considering the location of the drill holes and using special conditions in loading and tamping to reduce the pressure developed, a permissible explosive of a high rate of detonation could be successfully used in nearly all coal mines. It is well known that the pressure developed by the detonation of explosives in a closed space is directly proportional to the charging density; that is to say, a 1¾-in. drill hole loaded with 1½-in. cartridges will produce about half as much pressure per square inch on the walls of the drill holes as it would if loaded with cartridges of 1¾-in. diameter and, accordingly, explosives of a rapid rate of detonation if used in this manner would be productive of a better quality of coal. This procedure of air spacing to reduce the shattering effect is recommended by the Bureau of Mines.

There are other means of reducing the shattering effect of explosives, such as (1) the use of a weak detonator, (2) reducing the amount of stemming used in a drill hole, (3) using explosives that are frozen or partly frozen, (4) using cartridges of explosives of less diameter than were originally tested, (5) introducing foreign substances between cartridges of explosives, and other equally dangerous methods which not only eliminate the safety qualities of the explosives but enhances the chance of a resultant dust or gas explosion.

The American manufacturers deserve a great deal of credit for their efforts in producing suitable permissible explosives to meet the economic conditions in the coal mines of this country. Many of the permitted explosives used in European countries would not be suitable for use in the bituminous coal mines of this country for the reason that they are much stronger and quicker. If such explosives were used in mines of this country according to our American practice, depending to a great measure on the execution of the explosive, they would fail in their purpose. For this reason the American manufacturers have found it necessary to reduce the strength and quickness of explosives for coal mining purposes by adding inert materials or restraining substances. With explosives of this kind the average miner after a short time obtains successful and satisfactory results.

The ideal permissible explosive for use in shooting hard coal would be one that has a comparatively high rate of detonation containing all combustible materials and which on detonation produces the maximum volume of gases. Explosives of this kind could, no doubt, be used satisfactorily under all coal mining conditions, but, as stated before, they would have to be used in small quantities, in an intelligent manner, in coal previously mined so that the amount of explosive required would be that merely to exert a wedging effect on the coal.

This procedure is followed in many European countries and in some cases no explosives are used in friable coal or where the longwall system is used, but it is not expected that these conditions will obtain in this country for some time. Considering the comparatively high wages paid to miners in this country, cheaper coal can, no doubt, be produced with explosives rather than by pick work exclusively. But the excessive use of explosives, as practiced in many of our mines to-day, is certainly unnecessary and is a menace to safety.

NATURE OF PERMISSIBLE EXPLOSIVES.—In order that the users of permissible explosives may know the nature and characteristic component of permissible explosives, I will take up the different kinds of explosives as classified in Miners' Circular 2.

Class 1. *Ammonium Nitrate Explosives.*—All explosives belong to this class in which the characteristic material is ammonium nitrate. This class may be sub-divided into two classes; (a) containing a sensitizer which is itself an explosive, and (b) containing a sensitizer which is not in itself an explosive. All the ammonium-nitrate explosives mentioned in this circular belong to sub-class "a" with the exceptions of "Kanite" A and "Masurite" M.L.F. These two explosives contain sensitizers which are not in themselves explosive, and, accordingly, are classified under sub-class "b."

The ammonium-nitrate explosives of sub-class "a" consist principally of ammonium nitrate with small percentages of nitroglycerin, nitrocellulose, or nitro-substitution compounds which are used as sensitizers. The explosives "Aetna coal powder" AA, "Bental coal powder" No. 2, "Bituminite Nos. 5 and 7, "Coalite" 3X, "Coal Special" No. 4, "Collier powders" Nos. 3, 5, 6, Special 5, L. F., and X., and "Monobel" Nos. 1, 2, and 3 are explosives of this class and contain nitroglycerin as a sensitizer. They are similar in composition to or a slightly modified form of the English permitted explosives "Abbeite" and "Monobel."

The explosives "Hecla" No. 2, "Titanite" 5, 7P, and 3P are explosives of the ammonium-nitrate class under sub-class "a" and contain nitro-substitution compounds as a sensitizer. These explosives, as well as those which will be mentioned later, under sub-class "b," have the advantage of not freezing when exposed to low temperatures for the reason that nitroglycerin is not used as an ingredient. They are a modified form of the English permitted explosives "Withnell" and "Favorsham."

The ammonium-nitrate explosives of sub-class "b"; namely, "Kanite" A and "Masurite" M.L.F., consist principally of ammonium nitrate with small percentages of metallic oxides or other non-explosive compounds used as sensitizers. They are a slightly modified form of the English permitted explosive "Westfalite." They are detonated with difficulty, requiring an extra strong detonator and for this reason and the fact that they burn with great difficulty are one of the safest classes of explosives in respect to handling and transportation.

All of the ammonium-nitrate explosives are quite deliquescent, absorbing moisture from the atmosphere very readily. Great care should be exercised in storing them or using them in damp places. They are not suitable for use in wet mines. If an original package of an ammonium-nitrate explosive is opened in such mines and the cartridges are exposed for only a few hours to the damp atmosphere they will deteriorate, and many of the failures to completely detonate are attributed to this cause. The ammonium-nitrate explosives when stored under favorable conditions for only a few months show signs of deterioration, and nearly all explosives of this class, after six months' storage at the Pittsburg testing station, have failed to detonate or detonated incompletely when retested. For this reason the ammonium-nitrate explosives should be obtained in as fresh condition as possible and should be used as soon as possible after their receipt. The ammonium-nitrate explosives when in a fresh condition have the advantage of producing on detonation small quantities of poisonous and inflammable gases and are especially recommended for mines that are not annually wet and also in mines and working places that are not well ventilated.

Class 2. *Hydrated Explosives.*—All explosives in which salts containing water of crystallization are the characteristic materials and which modify the results of the explosion belong to this class. They are somewhat similar in composition to the ordinary low-grade dynamites, except that one or more salts containing water of crystallization are added to reduce the flame temperature. They are not now in general use and tests at the station and in the field indicate that the four hydrated explosives on the list at the present time are not as efficient as some other types of explosives. They have the advantages of being easily detonated, produce small quantities of poisonous gases, and can be used successfully in wet holes.

Class 3. *Organic-Nitrate Explosives.*—All explosives belong to this class in which the characteristic material is an organic nitrate other than nitroglycerin. The permissible explosives of this class are listed in Miners' Circular 2 as nitro-starch explosives. They do not contain nitroglycerin and for this reason do not freeze. They contain large quantities of inert matter and, therefore, are not as effective as they might be if they were made containing smaller quantities of this material.

Class 4. *Nitroglycerin Explosives.*—All explosives belong to this class in which the characteristic material is nitroglycerin. Of the explosives on the permissible list, 40 are classified as nitroglycerin explosives. The flame temperatures of this class of explosives are reduced by the addition of free water or by using an excess of carbon for the purpose of reducing the amount of carbon dioxide formed. A few contain salts which reduce the strength and shattering effect of the explosives on detonation. They are somewhat similar to, or a modified form of, the English permitted explosives "Britonite," "Carbonite," and "Kolax." The nitroglycerin class of explosives have the advantage of ease of detonation and not being readily affected by moisture. Less skill is required in their use and the average miner obtains satisfactory results with this class of explosives in a much shorter time than with the other ex-

*From a paper read before the West Virginia Coal Mining Institute, White Sulphur Springs, June 20. Prepared by permission of the Director of the U. S. Bureau of Mines.

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plosives. They have the disadvantage of freezing at comparatively high temperatures and even when nitro-substitution compounds or other materials are added to lower the freezing point they will not remain unfrozen when the temperature falls below 35° F. They produce a large percentage of poisonous and inflammable gases on detonation, many of them producing quantities equal to that of black-blasting powder. For this reason they should not be used in mines that do not have efficient ventilation.

DETONATORS AND FUSE.—Permissible explosives are detonated by means of common or electric detonators, the weights of fulminating charge varying according to the type of explosive used. When detonators are fitted with a means of firing them with an electric current, the device is called an electric detonator. As electric detonators are embedded in the explosives with which they are used and isolated by means of stemming, they are the safest means of igniting charges of explosives in gaseous mines. Common detonators are usually employed in connection with fuse. Fuse has therefore been called "safety" fuse and the practice still obtains, though the word "safety" has come to mean something far different than the original intention when associated with the word fuse. The variation in the moisture conditions of material to be blasted has forced the manufacturers of fuse to make several kinds in order that they will be adapted to the various conditions. There are five classes: (1) for use in dry material; (2) for damp material; (3) for wet material; (4) for very wet material; (5) for submarine work.

The first two classes are generally used in the coal mines of this country. They are the cheapest grades and, on account of the lateral sparking which obtains on burning, are not recommended for use with permissible explosives. If the detonator is buried in the explosive, the lateral sparking which occurs with these types of fuse may set fire to the explosive about it before the detonator is set off. This has been the common cause of inferior and dangerous explosions.

Classes 3, 4 and 5 are well-made fuse and these grades show little, if any, lateral sparking or glowing at the sides. However, even these classes of fuse are not considered permissible for use in gaseous mines. Tests made at the station, with fuse generally offered for sale in this country, have shown that the end spitting of the fuse will cause ignition of inflammable gas mixtures.

A new kind of fuse has recently been submitted at the station and the tests so far made indicate that it will be much safer than the fuse now generally used in coal mines. This fuse is of a good mechanical construction having a sufficient ratio between the pressure required to burst through the envelope of the fuse and the pressure produced within it by the burning powder train. The quantity of powder per foot is less than that which obtains in the ordinary fuse and in the preliminary tests which have been made at the station, no ignitions of inflammable gas mixtures have occurred from the spit of this fuse.

As fuse does not, per se, contain its own means of ignition, it cannot be considered apart from the fuse igniter, a means employed to cause the ignition of the fuse. Clearly, any fuse igniter that would ignite gas when properly attached to a fuse would be condemned as well as any fuse igniter which did not surely ignite fuse with which it is used. No great difficulty should be encountered when perfecting such a fuse igniter for there has been submitted to the Pittsburg station for test, a fuse igniter which, though it failed to pass the requirements, has some merit. It should not be concluded, however, that any fuse having the proper envelope and even when a safe and reliable method is provided for its ignition can be safely used in a body of inflammable gas.

There are various kinds of fuse sold of different rates of burning, varying from 18 seconds per ft. to 40 seconds per ft. when tested in the open air. The miner or shot firer seldom have the information of the rates of burning of the different kinds of fuse. It is true that some fuse is marked slow or fast burning and it is also indicated by different colors of paper wrapper, but this is not always the case. Without such information a miner may become accustomed to a certain fuse and on using another brand of a faster rate of burning, the charge may explode prematurely. This is a menace to all connected with the work. It is generally conceded that the use of fuse of different rates of burning is not desirable, that if all classes were made to burn about 90 seconds per yard in the open air and this rate maintained within 10% over or under the stated time, such requirements would meet all ordinary mining conditions and offer greater assurance of safety. The manufacturers of fuse realize that the many kinds now manufactured having different rates of burning are unnecessary, and they would, no doubt, welcome a universal rate. It is believed that the required rate of burning of fuse; namely, 90 seconds per yard, recently adopted by the Isthmian Canal Commission and the U. S. Reclamation Service, would meet the various mining conditions in this country.

Tests have shown that the spit from squibs invariably ignites inflammable gas mixtures. As squibs must be propelled from the mouth of the drill hole to its heel by a propelling power of the spit of the squib proper, it seems quite impracticable to adequately protect this spit from inflammable gas mixtures within mines and hence the use of squibs of any kind cannot be recommended for use in mines generating inflammable gases.

The system of firing shots from the surface when all men are out of the mine by the use of electric detonators, previously adopted in Utah, has been introduced in Colorado, Alabama, and other states. This method has many advantages, and its adoption in mines where the local conditions permit would, no doubt, reduce accidents.

The dangerous practice of using inflammable material for stemming is generally being remedied by the employment of clay and like substances in all parts of the country. The humidifying of mine air by means of steam and water sprayers has progressed rapidly in the last two years. The enforcement of the law by the state mine inspectors concerning coal-mining operations has greatly improved in recent years. The mining conditions of this country as regards preventitives of explosions are approaching a position of equality with European countries and it is expected that there will be a steady reduction of accidents from this source in the coal mines of this country in the future.

Discrepancies in Cement Testing.*

By F. C. YOUNG.†

The common physical tests applied to cement are those for specific gravity, fineness, time of setting, soundness, and tensile strength. The most commonly made and important of these is the test for tensile strength, and every engineer who uses cement must constantly accept or reject cements from a knowledge based upon the results of tests made by himself or others. The engineer should, therefore, be thoroughly familiar with the operations of cement testing in order that he may intelligently interpret the result of the same.

Only those who have made and broken cement briquettes can fully appreciate the innumerable difficulties involved in securing uniform results, but it is a matter of quite common knowledge that tests made by different testers at different times and under different conditions are not entirely comparable. Data‡ have been published which seem to show in a general way that the results of tests made at various times at any one particular laboratory are fairly consistent, but that they are not comparable with results of another laboratory. A study of numerous articles together with our own casual observance of apparent discrepancies in cement testing has led the writer to undertake, in the testing laboratory of the University of Iowa, a series of tests with a view to answering or at least shedding some light upon the following questions:

(1) Can one operator, with a fair amount of experience in cement testing, and following the standard specifications now in use, and using ordinary care, duplicate his own results upon the same cement with a reasonable degree of accuracy?

(2) Can two or more operators in the same laboratory produce comparable results?

(3) Are the results from different operators in different laboratories at all comparable?

If the answer to any or all of these questions is in the negative, then the more definite question immediately arises as to just what is the cause of these discrepancies, and whether or not they could be eliminated or lessened by more detailed specifications, or whether we are in need of an entirely new method of testing cement.

In considering these questions we must take into account the following factors:

Condition of the cement—age and previous environment.

Mixing water—amount, quality and temperature.

Mixing and molding the mortar.

Moist chamber—temperature and humidity.

Storage of briquettes—quality and temperature of water.

Breaking of briquettes—rate of load, kind of grips.

First, as to the condition of the cement to be tested, it is well enough known that apparently erratic results may be obtained upon a "green" cement because of the fact that, soon after burning, it changes its properties rapidly, being at first very quick setting and reaching a more stable condition in a few days, the length of time depending upon the amount of exposure to the air to which it may be subjected. For this reason the results of a test made upon a green cement immediately after sampling might be vastly different from the results of a test upon the same sample after it had been exposed to the air for some time. The changes in cement due to exposure become less as the cement becomes more seasoned however, so, upon a cement a few weeks old small ranges of conditions do not produce appreciable differences in strength.

Next, as to the water used in making the mortar for testing. Its temperature is required to be 70° F. and for ordinary laboratory ranges, say from 60° to 90° F., there is no appreciable effect upon the mortar. As to the quality of the water we have seen it stated that neither alkaline nor acid water should be used. We recently made, however, a large number of briquettes from a very strongly alkaline water taken from the storage tanks and, at the same time an equal number with a neutral water, and found no difference in the results. Since ordinary waters are practically never acid in reaction it has not been thought worth while to experiment with this kind of water. It has also been proven that salts in solution and ordinary suspended matter have no effect. When we come to the amount of water used we have a source of considerable error. The effect upon tensile strength of varying amounts of water has been investigated by many different testers and it is well known that for ordinary ranges of water, the dryer the mixture the stronger the briquettes. Fig. 1 shows the typical curve plotted from a large number of tests made by the writer. It shows that a range of about 20% in strength may be produced by using amounts of water varying from 18 to 22% of the cement.

The amount of water to be used in testing cement is that quantity which will give what is called normal consistency. This consistency is determined by the Vicat apparatus, which consists of a frame holding a plunger 10 mm. in diameter and weighing 300 grams. The mortar is pressed into a conical mold of given dimensions and placed under the plunger. If the plunger penetrates the mortar 10 mm. the mortar is said to have normal consistency. The correct amount of water is found by trial with this apparatus. The question of the amount of water then, is only one as to the reliability of this method of determining it. Of this we will have more to say later.

The third factor was the mixing and molding of the briquettes. Herein, without much doubt, lies the greatest difficulty in uniformity of tensile tests. The manner of adding the water, mixing the mortar, and placing in the molds is described in the standard specifications in as much detail as is thought advisable or possible. To describe in words such a procedure, however, so that every man reading them can go through identically the same process is a difficult task. For instance, in describing the mixing of the mortar, the American Society of Civil Engineers has stated, "the process being similar to that used in kneading dough." May it not therefore be expected that there will be used as many different kinds of manipulations in mixing cement mortar for testing as there are kinds in kneading bread? Shall it be as mother used to make it, or otherwise? And might we not carry the simile still further and expect as great a variety in the results of cement testing as in the results of bread kneading?

Next mentioned was the temperature and humidity of the moist chamber in which the briquettes are stored the first 24 hrs. It is well known that cold and moisture retard the setting of cement and thereby retard the tensile strength on short time tests. The specified temperature for the moist chamber is 70° F. and small variations therefrom seem to have no noticeable effect. As to the humidity, the specifications say, "care must be taken to keep the air in the chamber *uniformly* moist." In the light of some investigations made by the author, this precaution seems ambiguous. We accidentally discovered that if we placed briquettes in the moist chamber at the same time that water was poured in, the chamber being previously dry, the 24-hour briquettes would show a decided increase in strength over those treated normally. The only explanation seemed to be that the air in the chamber did not become saturated for some time, under such circumstances, and that, during this period of partial saturation, the setting of the cement was accelerated. The actual cause of the acceleration in the time of setting, at first thought, seemed to be explained by the relations shown in Fig. 2. That is, in the unsaturated air we assumed that moisture was evaporated from the briquettes in such quantities as to give the equivalent of a dry mix and hence a greater strength. A further study, however, showed the fallacy of this explanation.

Saturated air at 70° F. contains 80 grains of water per cu. ft., and since, the moist chamber has a capacity of only about 4 cu. ft. of air, it would take only 22 grains, or approximately 1½ cu. cm. of water to saturate the chamber when it was already at a relative humidity of 30%. Since this amount of water is less than 1% of the amount used in mixing mortar for five briquettes, it follows that the actual evaporation of water from the briquettes could not be the cause of the increased strength from a quantitative standpoint. It is known, however, that the setting of cement is a chemical process of crystallization which is retarded by excess moisture, and to this cause we must ascribe the increase in strength under such conditions.

In order to find what differences there might be in

*From "The Transit," a Publication of the College of Applied Science, State University of Iowa.

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‡See an article by Mr. Alexis Saurbrey in Engineering News, Dec. 9, 1909, p. 634 and the editorial comment in the same issue, p. 645.—Ed. Eng. News.

the humidity of the air in a moist chamber under various conditions the writer placed a temporary glass window in the door of the chamber and observed the relative humidity inside as indicated by a wet and dry bulb hygrometer. Fig. 2 shows graphically the length of time required to reach saturation under different conditions. The average strength of 50 neat 24-hour briquettes, subjected to the conditions represented by the curve D, was 20% more than the average of the

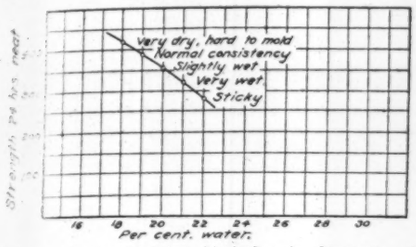

Fig. 1. Curve Showing Variation in Strength of Cement Briquettes Mixed with Different Percentages of Water.

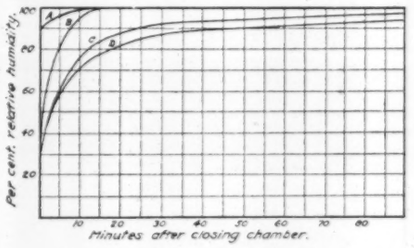

Fig. 2. Curves Showing Relative Humidity in Moist Chamber Under Different Conditions.

same number, mixed from the same cement, and subjected to the normal conditions of curve A. Although the conditions of curve D probably seldom occur in a well regulated laboratory, and need never occur, the results of these experiments are valuable in that they show that the air in which briquettes are stored should be saturated from the beginning of the storage. We suggest that an improvement in the wording of the standard specifications would be to make them read, "great care must be taken to keep the air space in the moist chamber *saturated*."

Next, as to breaking the briquettes there is a *possibility* of error. It is well proven that the rate of application of the load will affect the result, but since a rate of 600 lbs. per min. is specified, and all machines can be so regulated, there need be no differences on this account. Likewise the kind of grips is specified and hence very little difference is likely to occur on this account.

The effect of the storage water on long-time briquettes is very small if it is kept fresh and at approximately normal temperature.

With this knowledge of the various factors that may enter into the strength of cement briquettes there still is the final question as to what the combined effect may be under conditions, or as we have already stated it, "how nearly comparable are tests made in different laboratories?"

In order to answer this in the most direct and practicable manner, we have begun a series of tests in cooperation with six other laboratories.* We have shipped from our laboratory samples of three kinds of cement to each of the other laboratories, great care being taken to have the samples all alike. Upon these samples each laboratory has made tensile tests and reported the results, together with information in great detail as to the methods used. We purpose next to examine these results and see if we can discover any like results that have apparently been produced by the same causes. If so, then we will in a series of tests eliminate these differences of causes in so far as it is possible, one at a time, and see if we can fix the responsibility of the discrepancies.

This series of experiments is at this time only begun, and we have only the reports of the first test. The results are shown in Table I.

Every other laboratory used the standard specifications and the only thing which it seems could have affected the results was the amount of water used. The amounts used are shown in Table II.

TABLE II.

	Per cent of water—		
	X.	Y.	Z.
A	22.1	19.3	20.0
B	21.0	21.0	20.0
C	22.5	22.0	22.0
D	22.0	20.0	21.0
E	21.8	20.2	21.0

Every laboratory made the determination for the amount of water with the standard Vicat apparatus in accordance with the standard specifications. This shows, then, the accuracy that can be expected with this method. There is difference enough here in the amounts of water used, to make at least 10% difference in the strengths, but a study of the data shows that the dryer mixtures have not consistently produced the highest strengths as we would expect.

For instance, C obtained the highest strength on Z cement, 7 days neat, with the wettest mixture used. B obtained on Y cement, 24 hrs. neat 396 lbs., using 21% of water, while with only 19.3% of water, A obtained only 272 lbs. On the other hand, there are cases where the dryer mixtures did give comparatively higher results. The conclusion is that there are factors entering the results in some cases that overbalance the effect of water.

Another thing to be noticed concerning the water is that, A for instance, used 19.3% on Y, 20% on Z, 22.1% on X. Now we might expect that some other operator, due to a different manipulation in mixing the mortar, would find that all the cements required more water than A used, but he should find them requiring the same relative amounts, that is, Y taking the least water and X the most. Such is, however, not the case in these data. B used more water on Y cement than on the others, while C used the same amount on all three. This might be explained by the supposition that one operator's methods do not produce the same results on all cements, but it seems to us the more logical conclusion that the variations are all due to inaccuracies.

The most noticeable thing in the table of strengths is that the sand briquettes show consistently the greatest range, being about 50% in each case. This is as we expected, our experience showing that sand briquettes are less reliable than neat. Several of the laboratories, however, in correspondence, stated that they thought we need not include sands in the tests because they would show less variation than the neats.

In another, these ranges did not meet our expectations. We felt sure that the range in results would decrease with the age of the briquettes, but an inspection of the table will show that this is not consistently true.

Looking at the individual averages there does not seem to be anything very consistent about them except that, in general, the results of any particular laboratory are either higher or lower than the average.

TABLE I.—TESTS OF SAME CEMENTS BY DIFFERENT LABORATORIES.

Lab.	CEMENT X					CEMENT Y					CEMENT Z				
	Neat			1 - 3		Neat			1 - 3		Neat			1 - 3	
	24hr	7da	28da	7da	28da	24hr	7da	28da	7da	28da	24hr	7da	28da	7da	28da
A	280	510	710	240	225	310	710	900	200	295	410	665	725	195	320
	230	455	730	260	210	260	680	845	200	310	420	765	700	195	295
	280	485	690	230	300	260	710	900	190	285	445	760	730	175	265
	275	550	690	215	270	270	640	960	175	315	480	740	690	185	265
	245	485	730	240	300	260	625	815	180	300	405	730	790		
Average	262	497	710	237	261	272	673	884	189	301	432	732	727	188	285
B	275	780	770	180	240	370	705	830	150	215	400	660	770	205	345
	320	670	855	190	265	410	640	890	110	225	380	675	840	220	290
	285	780	775	180	275	420	740	880	155	245	435	675	790	205	275
	340	840	800	180	270	385	725	860	150	235	435	720	755	170	275
Average	305	768	800	182	262	396	702	865	141	230	412	682	789	200	296
C	267	597	774	250	451	236	674	1027	200	380	338	722	807	282	424
	271	600	795	280	445	239	683	1025	219	372	348	723	871	298	377
	289	604	836	292	483	265	689	1047	221	330	354	777	823	298	437
	298	629	836	294	413	280	701	954	228	350	362	779	917	300	428
	300	634	861	304	470	294	701	915	229	363	414	780	775	311	429
Average	285	613	824	284	443	263	690	994	219	359	363	756	839	298	423
D	325	550	655	220	310	315	710	860	195	260	425	645	700	240	315
	330	555	630	225	330	350	720	860	205	270	465	660	725	235	305
	325	550	695	220	315	345	720	820	210	260	445	640	710	255	305
	315	540	660	220	325	285	690	830	205	275	395*	650	580*	240	310
	305	540	675	225	320	285	725	880	200	280	425	665	705	230	310
Average	320	547	671	222	333	316	713	850	203	269	440	652	708	240	309
E	300	628	932	220	378	243	655	801	147	261	328	569	567	202	349
	296	611	896	262	378	231	680	721	161	278	353	685	510	229	261
	294	479*	927	229	323	280	642	796	104	289	370	632	595	220	264
	304	610	917	177	341	283	692	757	185	284	379	582	674	225	334
	294	660	667*	217	326	252	648	770	101	247	343	600	632	213	312
Average	298	627	918	221	349	258	663	769	140	272	355	611	596	218	304
Grand Average	294	610	785	229	330	301	688	872	178	286	400	687	732	229	323
Range Av'ges	20%	44%	19%	45%	55%	46%	7%	26%	44%	47%	21%	21%	33%	48%	43%

*Omitted from average.

*Five of these laboratories were the George Pierce Laboratory, Denver, Colo.; University of Illinois; University of Wisconsin; University of Nebraska and the State University of Iowa.

Our plan, as we have stated, was to pick out from these data such like results as had seemingly been produced by the same causes and then by subsequent tests eliminate the differences in causes. But, with the methods all the same, as nearly as our questions were able to bring out, and the results all so erratic, it is feared that no subsequent tests will add much to our knowledge. If there are any consistently varying results in the data, we have not yet discovered the fact.

Now if we can be allowed to draw any conclusions from this amount of data as to the comparability of results of tensile tests of cement what shall they be? It seems that the only thing we can safely conclude is that there is always a possibility of a range in results from different laboratories of as much as 50%. What does this mean to the manufacturer and to the user of cement? It means to the manufacturer that he must turn out a cement that has a surplus strength of 50% above the minimum of the standard specifications or he will be in danger of having his cement rejected. To the user of cement it means that he should put a very liberal interpratition upon the results of any one single test of a cement.

It has recently been suggested* that cement be sold at prices varying according to the strength of the cement delivered. We trust the foregoing discussion has shown the utter absurdity of such a proposition, assuming that the tests for strength were to be made according to our present methods. With a possible range of as much as 50% in the results of tests made at different laboratories, we are surely in no position to put the price of cement on such a basis.

Building a Reinforced-Concrete Pipe-Line In Alkali Soil.†

By ZENAS N. VAUGHN.‡

In determining the best form of pipe for a given installation, independently of cost, the three considerations usually given weight are strength, durability and discharge capacity. Where strength alone must decide the choice, the order of preference probably would be riveted steel, wood-stave, concrete; for discharge capacity, wood-stave, concrete, riveted steel; for durability, concrete, wood-stave, riveted steel. Local conditions may change this order, but the above arrangement will generally hold good. Cases are found in which other elements rank equally with those named. The Roswell Park project described below is one of these.

West of the village of Parma, and near that of Roswell, is a tract of land containing about 2,500 acres, where it was required to deliver water from the Riverside Canal, separated from this land by a long depression, in the lower part of which there is an alkali slough, several miles long. The lowest point in the slough is 70 ft. below the point of intake on the canal, and the controlling point of the land to be irrigated is 15 ft. below the point of intake. Therefore the pipe, when full, would be under a static head of 70 ft. and its discharge head would be 15 ft. The length of the line is 4,540 ft. The problems involved in the construction of this system will be discussed under two general heads; those connected with the main or trunk line, and those of the distributing system.

THE MAIN LINE.—In deciding upon one of the three classes of pipe above named several vexatious questions arose. If the pipe were to be built above ground, the problem of expansion and contraction worked against the adoption of either steel or concrete, while that of keeping the pipe full of water made wood-stave pipe objectionable. Troublsome considerations of right-of-way made any form of surface construction undesirable. As above intimated, however, a considerable section of the line would lie in an alkali slough. It was feared that steel pipe would not resist the chemical elements to which it would be thus subjected, so was not considered safe. The wood-stave pipe companies wrote vaguely of a protective coating which probably soon would be upon the market, but were too modest in their assertions of the efficacy of anything that was actually available to inspire confidence.

In the light of disclosures that have appeared in scientific papers relative to the effect of alkali on concrete it might seem that this material would be the most objectionable of all, and its availability was debated critically before adopting it. As a preliminary test concrete manholes in sewers and concrete building foundations in Parma, which had stood for a number of years exposed to the action of alkali in its worst form, or at least the worst form known to this locality, were carefully examined; but no trace of injury could be discovered. Concrete section corner markers, which had stood in the alkali soil of the tract where the pipe was to be laid for fully a year, were inspected with a like result. On the other hand, while it is admitted that the vicious action of alkali on concrete observed in

*Proposed by Mr. Richard L. Meade, before the American Society for Testing Materials; Engineering News, July 22, 1909, p. 105.

†Abstract of a paper in the May issue of the "Journal of the Idaho Society of Engineers."

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Colorado, Montana and elsewhere is very imperfectly understood, nevertheless, the authenticity of such action cannot be doubted. In the case under consideration, however, evidence of such action sufficient to call for the rejection of a material which seemed otherwise to offer decided advantages appeared to be lacking.

After the manufacture of pipe was begun, as a further test, a length of it was placed in the slough, where it would be exposed to the action of alkali under the most severe conditions that could be devised. This pipe has been examined from time to time, but up to the present date, after the lapse of about six months, no effect, capable of detection has developed. Notwithstanding the evidence thus gathered, it was thought best to fortify the pipe in every way that was practicable. To this end a sub-drain ditch was dug in the bottom of the trench and filled with cobble stones and coarse gravel, from which the sand and smaller gravel had been screened. Upon this filling the pipe was laid. After backfilling, a surface ditch was dug on each side of the pipe. Both the subdrain and surface ditches have an outlet into a main drain ditch which traverses the lowest part of the alkali slough, and are designed to carry off to the Boise River the water that may collect in them. By these means the site of the pipe line has been kept carefully drained, so that it is thought to be well protected. It is being carefully watched, however, and if necessary, other preventive measures will be adopted.

A concrete form of construction having been decided upon, the next question was, should the pipe be monolithic or jointed? After a thorough investigation by the writer, the monolithic form was rejected, owing to the great cost, and to the difficulty that has been met in preventing the pipe from cracking. The jointed pipe seemed to have met with success for static heads under 100 ft., the principal problem being that of making an entirely watertight joint. It was decided, however, that with proper precautions this could be done, and consequently a contract was entered into with the Reinforced Concrete Pipe Co., of Los Angeles, for the construction of the main line. Work upon this was begun in the latter part of April, 1910, and was completed early in July of the same year.

The pipe has an inside diameter of 36 ins., and a shell thickness of 4 ins. The form used in the manufacture of the pipe consists of an inside core and an outside collapsible jacket, made of rolled steel, fitted to rings, which give the proper shape to the bell and spigot ends of the pipe. The materials, with gravel screened to a size not greater than 2 ins. and remixed, were proportioned 1:2:3 for high, and 1:2:4 for low heads. The reinforcement was corrugated steel rods, wound spirally upon longitudinal spacing bars. The corrugated bars were so spaced as to take the strain at the various heads with a safety factor of not less than 4, the tensile strength of the concrete being disregarded. The ends of the longitudinal bars were looped, the hooks on the spigot end of one joint passing those of the bell end of the succeeding one, in such a manner as to admit a key bar, which was adjusted to the two semi-circular sections and locked the successive lengths together. The concrete was mixed "sloppy" and worked into the spaces between the spiral reinforcing rods with a tool designed for the purpose. As soon as the forms were removed the interiors of the joints were carefully washed with a neat cement grout. The pipe was then covered with burlap, and kept wet by sprinkling for a period of ten days.

When properly cured the pipe lengths were fitted together in the trench, which had been previously dug to grade, and subdrained, as above explained. The ends were locked, and to the joints were fitted flexible metal shields, each made in two sections, which met beneath the pipe, and were held in place by earth backfilled behind them. The joint was then filled with mortar, poured from a bucket. When this had properly set the shields were withdrawn. In the meantime, the interior of the joint was pointed with grout, and the inner surface of the pipe was given a second wash in a longitudinal direction.

The pipe crosses the drain ditch upon a concrete culvert, where it is provided with a 12-in. blow-off valve. At proper intervals three manholes were inserted in the pipe for convenience of inspection. At the end of the main pipe a concrete gate-chamber, octagonal in shape, was built, from which the water is drawn through steel gates, into the three main lateral pipes. The chamber is approximately 20 ft. high with walls 12 ins. thick reinforced with corrugated bars, spaced from 4 ins. to 9 ins. apart. The horizontal reinforcement is attached to vertical bars, spaced 12 ins. between centers. The concrete was mixed "sloppy," 1:2½:5, and carefully spaded.

When about four weeks old the pipe was filled with water in a test for acceptance. The pipe itself proved to be entirely impervious, even at the highest heads, but many of the joints leaked considerably. Fine earth and manure were thrown into the pipe, and the leaking decreased visibly, but persisted in places. The water was then turned out of the pipe, and the interior of the joints was given two coats of neat cement-wash, which practically stopped all leaks. The water stood in the pipe until about the first of October, when it was turned out for the winter.

THE DISTRIBUTING SYSTEM.—The problems involved in the manufacture of the lateral pipe have been different from those of the main line. The core and jacket form manufactured by a Covina (now Los Angeles) firm is used, which requires a dry mixed concrete. This allows the core and jacket to be removed as soon as each pipe length has been completed. The concrete is proportioned one part cement to three parts sand and gravel, the largest particles of the latter being about 1 in. in diameter. The mixing is done in a home-made wooden cube mixer, through which a 2-in. pipe extends diagonally, perforated in numerous places, for the admission of water to the mixture, which is introduced into the pipe through a funnel attached to one end. The mixer is operated by horsepower, through the medium of a shaft and gearing.

For reinforcing the lateral pipe a somewhat original plan had to be worked out, since the literature on reinforced concrete seemed to be silent on this subject. In Southern California miles of concrete pipe are in use, but there the ground is nearly uniformly level, and the heads are low, so that the pipe does not need to be reinforced. It is not deemed safe to trust a plain pipe for heads of more than 10 to 15 ft.; hence in a case where heads would run as high as 70 ft., it is clear that some effective method of reinforcing was a necessity. The dry mixture does not admit of the introduction of reinforcement at the time that the pipe is made; therefore a scheme had to be devised for reinforcing afterwards. The method of doing this is as follows:

Two movable bulkheads, with crank-handles attached, are so arranged that the pipe length can be firmly clamped between them. At a distance back of this device is a steel shaft, into which is cut a screw groove. Back of this, and parallel to it, a wooden shaft is placed for regulating the tension of the wire, and still back of this is a vertical spindle, from which wire unwinds automatically. The wire used for reinforcing is No. 12 gage, galvanized, having a tensile strength of between 500 and 600 lbs. A coil of this is placed vertically upon the spindle, the wire is passed around the tension shaft, thence into the screw groove on the steel shaft and is firmly attached at one end of the pipe by soldering in a loop. The pipe is then revolved by two men at the crank handles, by which process the wire is wound upon the pipe under tension, the spacing of the laps of the wire being made even by the screw groove. The spacing for different heads is accomplished by using pulleys of different diameters, to govern the rate of revolution of the grooved shaft as compared with that of the pipe. When the reinforcement reaches the end of the pipe length, the last two or three laps being made parallel, it is again soldered, and the wire is severed. A steel trowel curved to conform to the shape of the pipe, and suspended above it, is then dropped into place, and cement mortar 1½:1, is run upon the pipe as it revolves, the trowel smoothing this down to a uniform thickness. The bulkheads are then unclamped by a lever at one side and the pipe removed and properly cured.

In the trench the bell and spigot ends of the pipe are fitted together, as in the case of sewer pipe. Around the joint is placed a flexible form, made of very heavy canvas, attached to blocks of wood, sawed out in such a way that a space of about 1 in., measured transversely to the pipe, and 6 ins. longitudinally, is left vacant for the reception of the mortar. Along each edge of the form is run a 12-gage wire, terminating at one end in an iron ring, at the other in a tongue pin, curved in shape, so that when clamped through the ring, it draws the wire to a high tension, firmly binding the form to the pipe. The form is then filled with cement mortar, and immediately afterwards the interior of the joint is carefully pointed to insure water tightness, independently of the collar, as far as practicable. As soon as the collar forms can be removed, the trench is backfilled, to protect the collar while curing.

From the gate chamber issue three laterals, made of pipe as above described, one 24 ins. and two 20 ins. in diameter. At a distance of about 100 ft. from the gate chamber a sub-lateral issues from the 24-in. line, while at about the same distance one of the 20-in. lines is reduced in diameter to 18 ins. All pipes, of course, undergo repeated reductions of size in their onward course. The aggregate length of these four laterals is about four miles.

The system has been designed to deliver 1 sec.-ft. of water for each 80 acres of land to be served. In designing the system, Kutter's "n" was taken at about .013. Since the sub-laterals will also be mostly of pipe, thus practically eliminating seepage and evaporation, and since the land is to be used almost entirely for fruit raising, this allowance should be considered liberal. It happens, however, that there are a few points at some distance from the gate chamber whose surface elevations are nearly identical with that of the latter, hence a greater pressure head than that of the laterals had to be provided. This has been done by so designing the main pipe line that it will deliver the required amount of water with a reserve head sufficient to supply the water to this high ground. Furthermore, the system has been designed of sufficient capacity to deliver simultaneously the full quantum of water to every acre of land in the tract. Since it is clear that water will be required for all of the land at precisely the same time, a surplus head will result, which is relied upon, together with the reserve head in the gate chamber, and a certain amount of gravity reserve that was designed into lines where the natural grade of the land would admit of its being done, to fully serve land that is too high to be reached through the head found in the lateral itself.

Civil Service Examination for Civil Engineer Student, U. S. Department of Agriculture.

[Contributed.]

On March 8-9 the writer took the civil service examination for civil engineer student in the Department of Agriculture. The questions given, as written down from memory soon afterward, were as follows:

PURE MATHEMATICS.—Answer four of the following questions:

1. Find the total surface and volume of the frustum of a right cone of radii 17 ft. and 5 ft., and height 9 ft.

2. ABC is a plane triangle. $C = 57° 40'$, a = 15 ft., and $b = 624$ ft. Find A, B and c.

3. The equation to a curve is $y^2 - 3x^3 - 1 = 0$. Find (a) the tangents and (b) the angle between them.

4. The lengths of two parallel chords of a circle are C and c, the former being the larger, and their distance apart being d. Find the radius of the circle.

5. A street fence is d feet high and is a feet from a wall which is parallel to it. Find the shortest length of ladder which will reach from the street to the wall and just touch the top of the fence.

6. Two points, A and B, are f feet apart. If A and B interchange places, A travels the distance in S seconds less than B: If A and B are released at the same time, they will meet in s seconds. Find the time required by each point to travel the distance f.

(Another question involving the pressure of wind followed this, but the writer has forgotten how it was stated.)

MECHANICS.—Answer two.

1. A yellow pine beam 3 ins. × 12 ins. rests on supports 15 ft. apart and is subjected to a load of 8,000 lbs. at the center. If the deflection y at any distance x from the support is given approximately by the equation,

$$\frac{d^2y}{dx^2} = \frac{M}{EI},$$

find the maximum deflection, given $E = 1,200,000$.

2. The sides of a reservoir slope at 60°. (a) Find the pressure on a triangle (on the inside surface of the reservoir wall) whose base is 3 ft. and sides 5 ft., the base being 10 ft. below the surface of the water (weight of water per cu. ft. = 62½ lbs.). (b) If an orifice 2 ins. square is cut with the center on the base of this triangle, find the initial discharge in cu. ft. per min., neglecting friction.

3. A train of 150 tons of 2,000 lbs. each attains a speed of 45 mi. per hr. on a level in 2,400 ft. If the resistances are 12 lbs. per ton, find (a) the HP. developed at 1,200 ft., (b) HP. developed at 2,400 ft., (c) HP. necessary to maintain this speed, and (d) HP. necessary to maintain this speed on a grade of 88 ft. per mile.

INSTRUMENTS AND FIELD WORK.—Answer two.

1. (a) Give the two principles on which stadia work depends and derive the horizontal formula.

(b) show how to determine the members of the right-hand side of the equation.

2. Give a list of the precautions, positive and negative, which you would take to keep a transit in first class condition if it were given to you in such condition.

3. Sketch (a) cross-section of the objective glass, (b) of the erecting eyepiece. (c) What are the advantages of the erecting and inverting eye pieces. (d) What determines the magnifying power of a telescope?

MATERIALS OF CONSTRUCTION.—Answer three.

1. Give principal tests for Portland cement and briefly describe them. What is the average breaking stress for Portland cement and a 1:3 mortar at 7 days and 6 months?

2. State as many cases as you can where the use of cement concrete has superseded the use of other materials in construction and give the relative merits.

3. State the various uses of cement concrete and the relative merits in each case.

4. Describe briefly the processes of manufacturing Bessemer and open-hearth steel. Name other elements besides iron which are found in steel. Give their percentages and state their mechanical effects.

CONSTRUCTION.—Answer two.

1. Sketch and describe briefly the essential details of some form of pile driver and give method of operation.

2. Assuming pipes on line of work, give in detail the method of laying large cast-iron water pipes with designated grade and with tight joints.

3. Show good form of cross-section for a combined-system sewer (20 to 30 ins. diameter). Assuming average depth is 12 ft., give process of construction.

In regard to relative weights, each set counted 20 points, giving 100 as the total for the five subjects. The first two subjects were given on the first day with a time limit of five hours. The remaining three sets of questions were given on the second day with a limit of seven hours.

ENGINEERING NEWS

A Journal of Civil, Mechanical, Mining and Electrical Engineering

Published every Thursday by

THE ENGINEERING NEWS PUBLISHING CO.

220 BROADWAY, NEW YORK

BRANCH OFFICES

CHICAGO: 1138 Monadnock Block
WASHINGTON, D. C.: Home Life Building
SAN FRANCISCO: Monadnock Building
RUDOLPH MOSSE, BERLIN AND HAMBURG, GERMANY
Z. P. MARUYA & Co., Ltd., TOKYO, JAPAN

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Entered at the New York Post-Office as Second-Class Matter.

This number of Engineering News completes its 65th volume. We call the attention of our readers to the fact that the amount of matter contained in this volume (the index to which appears as a supplement to this issue), far exceeds that in any previous volume. The total number of pages in this volume is 796, and there are besides this 90 pages in the Engineering Literature Supplement which have been published during the past six months. This does not include, either, the 314 pages in the weekly Construction News Supplements which have contained, in addition to the regular Construction News, the monthly summary of engineering market prices. When all these are included, the total number of reading matter pages contained in this volume is found to be 1,200.

This increase in the quantity of reading matter furnished to our subscribers during the past six months has not been made by any sacrifice in quality. It is our steady aim to condense as much as possible the matter selected for publication in Engineering News, bearing in mind the needs of the very large proportion of our subscribers who bind their volumes for reference, and who, therefore, wish to have the reading matter no more bulky than is necessary.

The increase in the amount of matter is significant of the increasing scope and variety of the engineer's work.

Twenty-five years ago engineering covered a comparatively limited field. There was no need and no possibility at that time of making an engineering journal of such a size and covering such a wide range of activities. At present, however, the letters which come to us daily bear witness to the extent to which the pages of Engineering News are relied upon for information and guidance by engineers in all grades and all branches of the profession and also of the need of engineers for data upon fields of work which were not thought of as within the scope of the profession twenty-five years ago.

The bids for United States Government 3% bonds, opened at Washington, June 17, furnished a valuable index as to what capital is actually worth in the market at the present time. As has been generally made known by the newspapers, the $50,000,000 in bonds offered were subscribed for three times over at an average price above 102.

Notwithstanding all that has been said about the dullness of the bond market and the scarcity of capital seeking investment here as compared with European countries, the high price which these bonds have brought, compared with what the premier government securities of foreign countries are sold for in the open market, indicate that there is abundant capital available in the United States for investment in securities of absolute safety.

If, therefore, our railways and industrial corporations find themselves obliged to pay 4, 5, 6 and even 7% to secure capital for their business, it is not because capital is scarce, but because the investing public, warned by past experience, is distrustful of the integrity and efficiency with which our great railways and industrial concerns are being carried on.

The widely-published claims of railway magnates that the railway business was being ruined by state and national legislation, whatever its foundation or lack of foundation in fact, have had an important influence in making the public wary of purchasing railway securities.

Similarly, the exploits in high finance which have formed such an important part of Wall Street history during the past dozen years, have tended to make the public cautious regarding investments in industrial securities. Some of our cities, too, which have experienced difficulty in floating bonds at 4 or 4½%, may find a reason by studying with a critical eye some of the weak points in municipal finance which have become widely known to investors.

The recent widely advertised proposal to have the railways of the United States save a million dollars a day by the adoption of "scientific management" is called to mind by a piece of legislation enacted in Pennsylvania and signed by Governor Tener on June 19.

An essential principle of scientific management is that the output produced for a certain expenditure in wages is increased. To this end labor-saving devices and methods are introduced enabling the workmen to produce more in a given time.

Imagine, however, that one of the modern "efficiency engineers" were brought into a factory and invited to reform its methods; but be told at the start that the law requires that the machines which he sees in operation must have a certain number of workmen to tend them. It matters not whether the workmen are needed or not. The law says so many machines, so many workmen, and that ends it.

Under such conditions the "efficiency engineer" if he were wise, would inform his client that he could do practically nothing to aid him in reforming his business.

The law which is to go into force in Pennsylvania on July 20 requires every railway train containing 30 freight cars to have a crew of at least six men. Freight trains of less than 30 cars must have a crew of at least five men. Passenger trains made up of three coaches and a baggage car must have a train crew of five men, and, if there are four or more passenger cars in the train, the train crew must contain at least six men. Car porters or Pullman employees cannot be counted in these train crews. This law was urged before the Legislature by the railroad brotherhoods and was opposed by five presidents of railway companies and many railway officers.

A railway company manufactures transportation. Its principal machines are its moving trains. To enact a hard and fast law that there shall be a certain number of employees on every train, whether they are needed or not, is contrary to the first principles of scientific management. How important a matter this is to the railway companies may be understood when it is stated that of the total operating expenses of the railways, nearly 12½% is made up of trainmen's wages.

There might have been some slight shadow of reason in the enactment of a full-train crew law 25 years ago, when trains were controlled by hand brakes and when block signaling systems were hardly known. At present, however, the use of air brakes is compulsory on all railway trains, and block signaling is in use on a very large proportion of the roads moving heavy traffic. Under these conditions we know of no reason whatever why more than four men should be needed on a railway train for safe operation, and we know of no other excuse for such legislation than the claim that it is necessary to secure safety.

It has been currently reported that the real reason for the advocacy of the "full crew" train bills in various states was that the trainmen needed four men on the train besides the engineer and fireman, since otherwise it was impossible to play cards in the caboose!

While on its face the legislation may seem to be merely a demagogue thrust at the railways and an attempt to curry favor with the railway employees' unions, it must be remembered that the burden of expense imposed by any such law must be paid for in the long run by the public at large. The money to pay the wages of unnecessary employees on railway trains will eventually have to be paid in fares and freights by travelers and shippers.

It looks as if some apostle was needed in Chicago to preach the introduction of water meters. The following is an extract from the Chicago "Record-Herald," of June 11:

With the mercury at 98 and scores of heat prostrations reported, thousands of South Side residents suffered yesterday the effect of a water famine. Flat dwellers, particularly, were in want for water.

For several hours in the morning the complaints registered at the office of the Water Bureau averaged more than one a minute. Many were without water in their homes for cooking purposes. Bathing was out of the question.

"We have been without water between the hours of 6 o'clock in the morning and 11 at night, every day since Wednesday," said Harold D. Lumas, 35th St. and Cottage Grove Ave., yesterday afternoon.

Along Grand Boulevard, Indiana, Prairie and Michigan Aves., were scores of people yesterday who declared they had had practically no water in their homes for three days. Many sat up at nights until it was possible to fill basins, bowls, buckets and bath tubs from the faucets. Others got what water they could prior to 6 o'clock in the morning.

"All of the pumping plants are working to their fullest capacity," said W. J. McCourt, Superintendent of the Water Department, last evening when asked concerning the shortage of water on the South Side.

"This scarcity is due to the intense hot weather. Everybody in the city is using many times as much water these days as is used under ordinary circumstances. Bath tubs are being filled ten times during the hot weather where they are filled once at other times."

The famine covers generally the entire South Side, although it is most acute between 22d and 40th Sts.

Chicago is a city where the doctrine has long held sway that water should be free as air and no restriction upon its use should be permitted. With all Lake Michigan to draw upon, the layman might suppose that there could never be any lack of water in Chicago. Even a layman ought to be able to understand, however, that even constant pouring cannot fill a sieve. The water consumption (and waste) of Chicago is nothing less than criminal extravagance. The result is an enormous expenditure in pumping engines and water mains that would be unnecessary if leakage and reckless waste were stopped.

Mayor Gaynor of New York is opposed to the introduction of water meters because forsooth people would not take baths. We invite his attention to the object lesson furnished by the above quotation from a Chicago journal. The water meter actually contributes to good sanitation by insuring a supply of water for everybody. Mayor Gaynor will not find any such conditions in Cleveland, since Prof. Bemis introduced the universal meter system there, as are above shown to exist in Chicago with the "inexhaustible supply" which Mayor Gaynor considers ideal.

More Concerning the Relative Position of Europe and the United States as to Pioneer Inventions.

In our issue of June 8 we discussed in this column some of the reasons why most of the important pioneer inventions of the present day are developed in Europe and very few in the United States. We had hoped that our article was, to some extent, at least convincing to the reader; and we had supposed that the facts on which we based our discussion were pretty widely known among engineers of experience.

It seems that we erred. At least our editorial has drawn out a letter from a well-known and well-informed engineer, which we print below, in which our premises are attacked and our reasoning is challenged. Since our first article has failed of success with one reader, it very likely failed also with others; and it behooves us to try again.

We take our correspondent's letter as a text, and it runs as follows:

Sir: Engineering News is a mighty good paper. Its editors are worthy of all praise for the good work they do in selecting, from the vast volume of things that are offered them, only the very best, and editing them in such good style that it is a real pleasure to read them.

The best work an editor does is this work of selecting and editing, including of course the "boiling down" and "blue-penciling." The worst work he does is when he cudgels his tired brain to draw from his inner consciousness enough copy to fill one or two of the editorial pages, and instead of summarizing facts and news of the engineering world, he inflicts upon his readers a lot of half-baked opinions on subjects of which he has a very limited knowledge.

A recent example was the editorial statement in Engineering News that the Taylor system of scientific management was not a science. Another is the editorial in the issue of May 25, on "Why is Europe in Advance of America in Pioneer Inventions?" which question the editor answers as follows:

We believe the main cause is the wholesale consolidation which has taken place in American Industry. A huge organization is too clumsy to take up the development of an original idea. With the market closely controlled and certain profits by following standard methods, those who control our trusts do not want the bother of developing anything new.

The question should have been answered the same way that the king answered the question "why is it that when a live fish is put into a full pail of water, the water does not run over?" His answer was, "Let us first find whether it is a fact."

The editor has one single fact on which to base the conclusions of a two-column article, viz.: the fact that the Diesel engine is now in Europe being fitted to ocean vessels. All the rest of the article is either unproved assertions or mere opinion.

Before stating that the Diesel engine has been "ignored" in America on account of "American extravagance, carelessness and prejudice," it would have been well if the editor had posted himself as to the history of this engine in America, where it was introduced more than twelve years ago. Many other things besides extravagance, carelessness and prejudice were the reasons why its progress in this country has been so slow.

"We are to-day something like five years behind Germany in iron and steel metallurgy." A broad charge without a single specification or a single fact stated to support it. If Engineering News knows of anything in iron and steel metallurgy in which Germany is five years in advance, it is surely its duty as a leader in American engineering journalism to make it known. The editor ought to take a trip to see some of our American iron and steel works, say in Bethlehem and Pittsburg, Pa.; Gary, Ind., and Ensley, Ala., whose "huge organization is too clumsy to take up the development of an original idea," and then let us know in what respect these works are five years behind Germany. Here is a partial list of rather modern things he will find in our works. How much longer or better list can he get in German works?

BLAST FURNACES.
Automatic Charging
Pig Iron Casting Machines
Uehling Pyrometer
Gas Blowing Engines
Gayley Dry Air-blast
Gas-driven Electric Generators.

HOISTING & CONVEYING.
High-speed Elevators
Car-dumping Machinery
Belt Conveyors
Automobile Trucks
Telferage
Trenching Machines
Electro-Magnetic Hoists.

STEEL WORKS.
Continuous Heating
Tilting Open-hearth
Talbot Process
Duplex Process
Charging Machines
Soaking Pits
Jones Mixers
Extra Soft Open-hearth Metal
Electric Melting.

FOUNDRY.
Molding Machines
Jarring Machines
Core-making Machines
Electric Cranes.

GAS PRODUCERS.
Revolving Grate
Water Bottom
Hughes Stirrer.

ROLLING MILLS.
Continuous Rod Mills
Universal Plate Mills
Electric-driven Rolls
Flying Shears
Grey Beam Mill.

MACHINE-SHOP.
High-speed Steel
New Turret Lathes
New Gear Shapers
Electric Driven Tools
Multiple Drills.

America is at least abreast of Germany in railways, 50-ton freight cars, Mallet and electric locomotives, steam-boilers, automatic stokers, pumping engines, multi-stage centrifugal pumps and blowers, steam turbines, automobiles, motor boats, storage batteries, aeroplanes, telephones, wireless telegraphy, type-setting machines, agricultural machinery, high-voltage electric transmission, vanadium steel, vacuum cleaning, and labor-saving machinery in general. Most of these modern things have been developed or adopted by the "huge and clumsy" organizations. A fine instance of progress by one of these organizations is given in the same issue of Engineering News in the article on the Underground Trunk Lines of the American Telephone & Telegraph Co.

Five years ago the writer visited the newest of the Krupp steel works on the Rhine. The blast furnaces had modern charging apparatus, then old in America and gas-driven blowing engines, which had already been installed in the Buffalo works of the Lackawanna Iron & Coal Co., and which were soon afterwards adopted for the Gary works of the U. S. Steel Corporation; but in the rail mill there was found the old method of feeding the rolls by hooks operated by manual labor, which had been supplanted by mechanical feeding tables in all the American mills twenty years before. The Germans may lead the world in scientific research and in pioneer inventions relating to the saving of fuel, but the Americans are still ahead in inventions relating to the saving of labor.

The writer holds no brief for the trusts, and recognizes as well as the editor does, that they are liable to become, if they are not already, engines for the oppression of the public, but he recognizes the fact that many of them are more progressive in the acceptance and development of new ideas than the smaller corporations are, and that some of them are maintaining research departments for the very purpose of developing new ideas.

Wm. Kent.

Montclair, N. J., June 20, 1911.

On the algebraic principle that equal quantities on the plus and minus sides balance each other, we might perhaps have allowed our correspondent's compliments to offset his criticisms and have published his letter without comment!

But if our correspondent will pardon us, he has based his criticism on erroneous assumptions. An algebraic computation may be carried through without error; but the final result is no more accurate than the original assumptions on which it is based.

Our correspondent assumes at the outset that "the editor of Engineering News cudgels his tired brain to inflict upon his readers a lot of half-baked opinions on subjects of which he has very limited knowledge."

We assure our correspondent that we can make a very much better use of cudgels than that!

Let it be understood in the first place that we make no sort of claim to infallibility in editorial opinion or utterance, nor pretence of ability above our fellow-engineers. If the Editor of Engineering News actually "cudgeled a tired brain" merely to express an individual personal opinion upon matters of interest to the profession, then the editorial pages had better go to the reader blank, or if printed, be unread.

We suggest to our correspondent, however, that the reason and excuse for these editorial pages is that the *editors* of Engineering News (note the plural) do have opportunities to gather information on a wide range of engineering matters that are not available to engineers generally. It is not merely the current engineering literature and the contributions of engineers all over the country and all over the world that are laid before us. A wide personal acquaintance and extensive correspondence by the various members of the editorial staff puts the editors in close touch with many matters of interest to engineers and enables us to reflect in these pages not merely the individual ideas and opinions of the writers, but ideas and opinions expressed by leaders in many branches of the engineering profession.

Thus it happens that the editorial "we" of Engineering News is not a misnomer, as in the case of the editor of a country newspaper in Colorado who, in describing his visit to a mine, wrote: "At a steep place in the trail our mule s[illegible]ed and we fell off and bru'sed our right leg."

It often happens that an editorial in E[illegible]ing News represents the joint work of [illegible] more members of the staff, and it m[illegible] opinions and information gathered fro[illegible] widely scattered sources.*

Turning now to the main question [illegible] our correspondent challenges us, let us [illegible] at once that our statement as to the relati[illegible]stion of Europe and America in pioneer in[illegible]ons was not based on any one or two isolate[illegible]cts, as our correspondent assumes.

On the contrary our statement was bas[illegible] on a very great amount of information obtain[illegible] from a variety of reliable sources. It would [illegible]uire far too much space to recite all these [illegible]s at our command or any considerable num[illegible] of them. We are obliged to content ourselv[illegible] with a few of the most striking and we d[illegible] our illustrations almost wholly from what our [illegible]rre-spondent himself cites.

Referring first to the Diesel engine, [illegible] are perhaps better informed as to its histo[illegible]here and in Europe than our correspondent [illegible]mes. We may add to what we said respecti[illegible] it in our former article that at the present t[illegible] it is being built by a considerable number of the most prominent works in Great Britain, Germany, Switzerland and other countries, and is being applied to a great variety of uses. Notwithstanding the fact that the basic patents have expired so that any concern may build it, only a single firm in the United States to-day is selling Diesel engines and even this concern is not yet on a basis to push them on the market, in competition with other machines.

In oil engines, the principal business in the United States has been done by a German concern manufacturing an engine invented in England. In the development of gas producers and suction gas engines most of the work done in this country has followed after the pioneer work done on the other side; and, notwithstanding the great stimulus to the use of the gas engine afforded by our stores of cheap natural gas, the internal cumbustion engine for power purposes is far more largely used abroad than here.

Regarding the comparative progress of Germany and the United States in iron and steel metallurgy, we may remark that one of the editors of Engineering News was the official delegate of the United States to the International Congress of Mining and Metallurgy at Düsseldorf, Germany, a year ago this month. Two other engineers from the United States were in attendance at the Congress who are as competent to express an opinion as any engineers who could be found anywhere. These two Americans expressed independently that estimate of comparative progress in the two countries which our correspondent challenges.

Nor was this statement, in fact, new. It is perfectly well known that the blast furnace gas engine, which our correspondent cites as one illustration of American advancement, was fully developed and in successful commercial use in Europe about five years before it was taken up here.

It happens that one of the editors of Engineering News also saw blast furnace gas engines at work in Europe eleven years ago, and learned considerable concerning their use there. This was about four years before the first blast furnace gas engines were installed at the Buffalo works of the Lackawanna Steel Co., which our correspondent cites as an example of American up-to-dateness. This first installation in America, moreover, was not particularly successful, and Americans have improved in later installations

*Commenting on a bill introduced in the New York legislature requiring the signature of the writer to be appended to every editorial published in a newspaper, the New York "Evening Post" of June 22 said:

"Editorial matter does not always come intact from a single pen. It is the result of collaboration, often of extensive changes and re-writing. The truth is that there is more than some people think in the editorial 'we.' The opinions expressed are the result of the consent of different minds, and the form itself is frequently the result of much emendation and recasting. There can hardly be a week in which a newspaper does not publish an editorial, long or short, of which no one man was the writer, and which no one man could conscientiously sign as his."

merely by following more closely the lines of established German practice.

Our correspondent cites the electric steel furnace as a sample of American progress; but he ought to know that European inventors did the pioneer work in this field, also, and electric steel melting furnaces were in extensive commercial use in Germany before American steel makers thought it worth their while to take up this new invention.

Of course, it is an old story that Bessemer and Martin and Siemens and Thomas, and Mushet, the great pioneers of steel making, were all Europeans. It is an old story, too, that notable contributions were made to the steel making art by such pioneers as Wm. R. Jones and Alexander Lyman Holley, some of whose inventions our correspondent includes in his list. We are talking, however, about the pioneer inventions of the present day. The main point to which we wish to direct attention is that conditions are far less favorable to the development of pioneer engineering inventions in this country than they were a quarter century ago.

Space permits only a brief review of a few of the inventions cataloged by our correspondent. We are well aware that in some fields, such as typewriters, type-setting machines and high speed elevators, Americans have been pioneers; but how about some of the other items—some of the developments of most far-reaching importance?

Take for example the steam turbine. The pioneer American steam turbine inventor Dow, lacked the technical knowledge to make his invention a commercial success, nor was he able to secure capital to develop it. So the honors for pioneer work go to De Laval, the Swedish engineer and to Parsons, the Englishman, while Curtis, another Englishman and Rateau, a Frenchman, and Zoelly, a Swiss, and Riedler and Stumpf, in Germany, are the engineers who have won distinction in the later development of the steam turbine.

As for the multi-stage centrifugal pumps and blowers, these were in extended and successful use abroad years before they were taken up in the United States. France developed the automobile far ahead of either England or America. Telferage was originally invented by an English professor of engineering.

As for pioneer inventions in the railway field, the most important developments of the past five years in this country in locomotive design have been the Mallet locomotive (invented by the French engineer, Antoine Mallet in 1888), and the use of superheated steam, for which credit must be given to the German, Schmidt.

We could continue at much greater length to show wherein Europe is far in advance of America at the present day in pioneer inventions; but it is not a pleasant duty and we trust enough has been said to convince the reader that we wrote with something more than superficial knowledge.

It may not chime well with the spread-eagle tone of the Fourth-of-July orations soon due to say that the United States no longer leads the world in the race of invention; but it is better to know the truth than to delude ourselves with false pretensions to supremacy.

And now as to the reasons why this country no longer leads. It is not because American engineers and inventors are less ingenious or less progressive than those of other countries, though it may well be that the thorough work done by the German technical schools gives them some advantage in the development of inventions requiring a high degree of scientific knowledge.

We said in our former issue and we now repeat that the main reason, in our opinion, is that under the present organization of American manufacturing industry, invention and innovation is discouraged rather than encouraged. And this opinion is based, not alone on knowledge of the actual experience of numerous American inventors and engineers, but on the frank statement of officers connected with some of our large industrial corporations.

We could cite the case of an American inventor who, after vainly endeavoring to secure capital for his work in his native country, went to England and won fortune, fame and honor. Another particularly pertinent example is the Gray beam mill, cited by our correspondent above as an example of American supremacy in pioneer inventions.

The facts are that the inventor of the Gray mill for rolling wide-flange I-beams, after developing his invention and actually demonstrating its merits, was unable to market his invention with our excellent steel magnates. They were not *obliged* to have his invention. They were making money by the cartload in consolidation and promotion and stock market manipulation. Why should they bother with such a trifle as an improved system of rolling beams?

Mr. Gray therefore went abroad and the Belgium steel plant at Differdingen promptly took up his invention and developed a large and profitable business thereby. Returning to America after this success abroad, Mr. Gray was even then unable to secure a favorable hearing from the steel mill managers, whom Mr. Kent praises so highly. It was not till the Belgian plant had been rolling Gray beams for five years that Mr. Schwab took it up at Bethlehem. This former Steel Corporation president, engaging in a strenuous campaign, of competition, may perhaps, for this reason, have been more receptive to new ideas. At any rate the success of the "Bethlehem beams," and the tardy imitation of these shapes by other American steel mills, justifies his venture and proved the ultra-conservatism of those managers who, years before, rejected the Gray rolling process.

We are well aware that the huge industrial combination has some advantages in undertaking the development of new inventions over the small concern. We are aware that some of our trusts do maintain research departments, and it is currently said that one important use of these departments is to defeat the independent inventor and discourage the undertaking of original invention in the field which the trust aims to control. We are well aware, too, that there are numerous lines of labor-saving machinery which have been developed in the United States, but not abroad, because of the great difference in wage scales here and there. All this has nothing to do with our contention that the United States has lost its supremacy as a field for the development of pioneer inventions and that in the race of international competition we are falling behind because of the attitude of the trusts toward inventive progress.

LETTERS TO THE EDITOR

What is the Coefficient of Expansion of Terra-Cotta?

Sir: I am very desirous of knowing a value for the coefficient of thermal expansion of terra cotta. I have made extensive searches for such information, but, to date, have been able to find nothing. I would be very greatful to you if you can give me this information or reference to some article which might contain it.

Edgar K. Ruth.

335 Madison Ave., New York City, June 1, 1911.

[So far as we know there have been no tests made that would furnish this information. We understand that the U. S. Bureau of Standards contemplates undertaking such an investigation.—Ed.]

Photography in Engineering.

Sir: The letters which have appeared in various issues of Engineering News since the article by Mr. Jeffrey (April 6), are reminders that many engineers who practice picture taking for themselves sacrifice good results to the conveniences and ambitions of the amateur photographer whose highest purpose is to turn out photographs that will be regarded as striking and "artistic." Now there is no objection to the photograph of an engineering subject being a "nice" picture, but for engineering purposes, to be good, it should be truthfully expressive of proportions and relative positions of objects.

The hackneyed phrase that "a photograph can't lie" may ordinarily be true with respect to mere presence of objects, but the pictorial insinuation of relative sizes and proportions of objects may be far from truthful. Many engineers have experienced such chagrin at deceits implied by poor photographic representations that they regard photography as mischievous rather than beneficial to their work and worthy of no higher respect than the tantalizing little picture effect perpetrated by the average school-boy.

Photography has obtained such a strong hold, however, as a convenient and popular method of illustration that it cannot be ignored in engineering work and, whether or not an engineer practices photography for himself, he can now scarcely afford to neglect consideration of certain geometrical conditions essential for good photographic representation. For the benefit of those who have not solved questions of photographic perspective to their own satisfaction, the writer ventures to refer, in common terms, to what appears to be the leading causes for imperfect interpretation of photographic views and to point out simple remedies that may be adopted in ordinary picture making.

The failure of most photographs to impart true perspective values to the average observer is not so much due to imperfect projection by the lenses employed as the method taken by the observer in examining the pictures. Nearly all photographic views, whether produced by professionals or amateurs, if made with ordinary sharpness of definition, may be considered as delineated in true mathematical perspective. But original camera pictures can present, to an observer, true perspective proportions of the objects photographed only when the photographic dimensions are such that the picture can be distinctly observed when the observer's point of sight is in the axis of the view, and at the same distance from the picture as the focal length of lens that took the picture.

As the least distance from the eye at which the average individual examines a picture or other object is 12 to 14 ins., it naturally follows, that unless the focal length of lens employed in taking the picture is at least 12 ins., true perspective values will not be apparent to the average observer unless he examines the picture with a lens of the same focal length as that which took the picture or the scale of the camera picture has been sufficiently enlarged to increase the corresponding focal length to at least 12 ins.

The leading defect of small hand-camera pictures, printed directly from the original negatives, is that the camera lenses employed are so much shorter of focus, than the distance required by the average observer for examining the photographs, that true perspective effect is lost to the observer. The defect may be overcome by employing lenses of sufficient focal length in so-called "long focus" hand cameras, but these instruments, besides being more expensive than ordinary cameras, are not obtainable in convenient and rugged form suitable for every day use and, unless equipped with rapid rectilinear lenses adapted to the long focus, do not produce pictures having satisfactory definition. If nothing but sharp definition will fulfil the requirements of the photograph, or it is known that a large number of prints will be required, then it will be advisable to take the photograph with a lens of 12 ins., or longer focal length; otherwise any short focus camera and lens may be used provided the negatives obtained are sufficiently sharp for making good enlargements to a scale that would relatively magnify the focal length to 12 ins. or more.

But even though the photographer has supplied a picture of sufficient focal length for the observer to examine it at the proper focal distance, perspective effect remains lost to him unless he places his eye correctly with reference to the picture. The observer's selection of distance is always a matter of concern to artists, and many draftsmen in perspective make a practice of boldly stating the proper distance on the margins of their drawings.

Our picture to be well received, therefore, needs to be made with reference to the observer's natural selection of distance. In examining a picture most persons will undertake to range the eye at such distance that the field of view will be embraced by a horizontal angle of about 30°. This corresponds very closely with a rule common among perspective draftsmen, as follows: Construct the picture with a distance of point of sight, 2½ times the horizontal length of the picture; in other words, when the horizontal length of a picture is about 40% of the focal length, and perspective distance is not too short for distinct vision, then the average observer is most likely to select the proper distance for "obtaining the perspective."

More than 20% of "focal length" of a photograph each side of the center should therefore be discarded, or the observer is pretty sure to assume too great a distance and thereby lose perspective effect as completely as though examining a direct camera picture made with lens of less focal length than the observer's least distance of distinct vision. No matter what the scale of a picture may be, there always is some error in perspective interpretation from binocular vision of the observer, but in viewing a picture at a distance of 12 ins. or more most persons appear to accommodate themselves to this error much more readily than they do to greater proportion in length of picture.

If it is impractical to obtain proper focal length either directly from the camera picture or by enlargement of the camera picture, then it will be found that true per-

spective impression on the observer of the picture is obtained to a very large extent, by trimming down the picture symmetrically each side of the center to about the same (40%) proportion of focal length as would be employed for good interpretation of long focus pictures. The improvement is probably due, more than anything else, to the fact that the observer, finding himself invited to adjust his point of sight to distance less than that of normal vision, regards the picture as a reduced scale of the normal proportions. The improvement is readily observed by lopping off the sides of any very short focus camera picture and is not so much due to the fact that the center of the picture is cut by the lens in truer perspective, but because it results in perspective angles and proportions that are naturally anticipated by the observer.

Most hand cameras that are made for use of amateurs are arranged for taking oblong pictures and, in using them for photographing engineering subjects, it is well to make exposures so that the shorter dimension of camera picture will be taken horizontally, and thus better insure against the pictures being finished with excessive horizontal proportion. As vertical dimension of a picture is of much less importance in influencing truthful interpretation of perspective, the vertical dimension of a picture may be trimmed according to taste and the requirements of the subject.

But good horizontal proportion, as we have seen, is essential to good picture making, and from the fact that it rarely needs to be violated, it should never be neglected in any work that the photographer wishes to call good.

The 3A kodaks and film-pack cameras so popular among engineers, take pictures 3¼ × 5½ ins. and are usually equipped with lenses of focal length of about 6½ ins. These cameras are light, compact and convenient and are capable of rendering good engineering pictures provided due attention is given to the proper horizontal angle of view of the finished pictures. For obtaining the horizontal proportion we have named as requisite for good pictures of engineering subjects, the focal length of lens (6½ ins.) requires that the center of the picture made with one of these cameras should have no greater length than about 2¾ ins. This of itself, will be a very fair representation of the subject photographed, but by enlarging the picture in that proportion of horizontal length to twice the scale of the camera picture we obtain relative length of focus and all other geometrical conditions that are requisite for truthful interpretation of perspective. Such a picture, if made with usual care in other respects, cannot fail to secure fullest confidence in its veracity.

Franklin Van Winkle.

Consulting Engineer, Paterson, N. J., June 23, 1911.

Photography for the Engineer.

By EMILE LOW,* M. Am. Soc. C. E.

After reading the recent articles in Engineering News on "Photography for the Engineer" (April 6, May 11, and June 8) the writer is led to contribute the following remarks based on his own experience in the belief that they may prove a useful addition to what has been printed.

Photography has taken such an important place in the engineering field that we find the illustrations with descriptions of engineering work largely photographic reproductions. The reason is not hard to find as the process shows actual conditions with utmost fidelity. Without the great aid of photography, even Engineering News could not present many of the interesting comparisons seen on both reading and advertising pages.

In modern engineering work, at least in work of any size and under progressive management, we see, as a fixed member of the engineering organization, a photographer whose duty it is to prepare a pictorial record of work from start to finish.

In the instructions to engineers for making surveys, maps, plans and estimates, for the New York State Barge Canal, issued by the State Engineer and Surveyor, the following requirement, relative to "data required regarding present and proposed structures," is found:

> Take one or more photographs of existing structure or location with a view to illustrating general, as well as special, features. Include as far as possible all points which will aid in the preparation of design for new structure. Photographs to be from 5 × 7 plates, Velox paper, unmounted, and forwarded with other data furnished for the location.

The "other data" spoken of is a complete and comprehensive survey and map (or, in other words a situation plan) for a required structure, be it a lock, bridge, spillway or other necessary structure. In addition photographs of buildings likely to be destroyed by the canal construction had to be taken in accordance with the following instructions:

> When making surveys for the purpose of making maps of lands and buildings proposed to be appropriated, please have taken, photographs of buildings upon the appropriated parcels. These photographs are to be forwarded with the appropriation maps.
>
> These photographs are to be taken upon 6½ × 8½-in. plates printed on Velox paper, left unmounted, and forwarded flat, i. e., not rolled.
>
> Mark in pencil upon the back as follows, filling in the blanks with the information required:
>
> Parcel No.....Appropriated Lands, Town, County,
> From.....name of reputed owner,
> Kind of building, dwelling, stable, shop, etc.,
> Photograph by.....(name of photographer and address.)
> Date.....
>
> The mounting of the photographs will be done in Albany, also the numbering of the parcels.

The above instructions relate to "Preliminary Survey Work." In addition we find in the "rules governing construction," the following, being paragraphs 68, 69 and 83.

> Photographs. The Resident Engineer by arrangement with the Division Engineer will be furnished with a photographer. Photographs illustrating the monthly progress of the work are to be forwarded to the Special Deputy State Engineer with the monthly estimates and other papers.
>
> Photographs are to be on Velox paper, not mounted, and on such a plate that a 5 × 7-in. picture may be filed.
>
> An album of photographs for each contract shall be kept in the office of the Special Deputy State Engineer and all photographs received from the Resident Engineers as hereinbefore provided are to be entered and preserved.

The following few paragraphs are taken from the rules governing surveys, plans, and construction of the New York State Highway Department:

> Surveys.
>
> A small camera will be furnished each survey party and photographs shall be taken of any bridge, culvert, retaining wall or other object or place, the treatment of which, in preparing plans, will in the judgment of the engineer in charge, be a matter requiring extra precaution or study.
>
> It is not desired that photographs be taken of any objects or places, the proper treatment of which presents no unusual features.
>
> All films must be carefully listed, and the prints, when made, must be pasted in the note book near the proper station. Developing and printing may be done at the office of the Division Engineer.

The writer held, for several years, the position of Resident Engineer on the New York State Barge Canal and can testify that photographs of a building site are a great aid in the preparation of designs for structures. Oftentimes obscure portions of a map are cleared up by the inspection of the photograph, which is the next thing to being on the ground itself.

On one of the proposed lines for this canal, a very large number of bridges had to be raised or rebuilt, spanning the present Erie Canal at Rome, N. Y., and where it was necessary to obtain much detail, showing their construction and condition. Photographs of these bridges showed what was wanted and the information was more readily obtained in this way than by actual measurements and sketches of the structure, the original plans and drawings not being available.

On construction, photographs show more readily the status of the work than any long-drawn-out description. This is forcibly brought to mind in the article "Slides on the Panama Canal" in Engineering News, May 11.

Where photographs are taken in large numbers, it is very essential that a proper filing system be maintained so that negatives and prints are readily identified and found when wanted. The writer has had a large experience in taking photographs and in filing such records, and he wishes to outline herewith a method which has given great satisfaction.

The first requisite is a filing cabinet for negatives. Such a good one is modeled on the lines of the old-fashioned document file. The filing boxes are made to suit any desired size of negative, but the writer prefers the 6½ × 8½-in. size. To hold these, the boxes should be (inside measurements) 8 ins. wide, 11 ins. high and 12 ins. deep. The negatives should be kept in strong, special, paper envelopes, on the face of which should be printed the data shown below. A good size for the envelopes is 7 × 9 ins. Smaller negatives, of course, require smaller envelopes.

Other information can be added as experience may suggest, it being well to have a complete record of the photograph, as oftentimes it figures as important evidence in lawsuits and disputes.

Accession No..... Special No.....
Name of Department.....
or Work .....
.....
Name of Contractor.....
Date of contract.....
Date.....
Hour.....M.....Weather.....
Camera, kind, size.....
Lens.....do.....
Plate..... Stop No.....Exposure.....
.....
SUBJECT.....
.....
.....
Taken by.....Address .....
Developer.....
.....
Printing, for Velox per....inches....min.....

No space will be taken to discuss development here save to remark on the growing belief that since the daylight film cartridge and developing tank have been invented the dark room has become obsolete, for certain amateur work.

When a negative is ready to file, several blue print copies of the same should be made on 6½ × 8½-in. sheets and a copy pasted on the back of the envelope, always in a prearranged order, with reference to the face of the envelope, so as not to be "up side down." Other prints should be on 8 × 10½-in paper, with top, bottom and right-hand margin of ¾-in. and a left-hand margin of 1¼-in. for binding. To print these larger sheets an 8 × 10½-in. printing frame is used, into which a brass "kit" is placed having a proper center cut out. The larger sheets are kept in loose-leaf covers, consecutively, according to the order (numbers) taken, or according to subjects. Or else by using a vertical letter file, the prints can be kept in envelopes in such order as fancy, convenience or exigency may suggest. No matter what the system of filing may be, a card index should be also used, with a card for each negative or print containing the same information as the envelopes, or else only the number and subject.

On extensive construction work, there is hardly any question but what the 6½ × 8½-in. plate is the proper size. But any smaller one can be used, since it is much like using large or small type for reading matter—the larger is more legible.

The instructions relating to the filing and indexing of photographs, as found in the Book of Regulations, Board of Water-Supply of the City of New York, are of sufficient interest to be given in full here (paragraphs 129 to 134 inclusive):

> Photographs are to be of uniform sizes, 6½ × 8½ ins. for outdoor work and 7 × 10 ins. for copying drawings. For special work suitable sizes may be permitted.
>
> Finished photographs for the official file at Headquarters' office are to be printed on 8½ × 11-in. heavy, unmounted Velox, platinum or other paper, giving a permanent black or grey picture on white ground. Photographs for department files may be like those for Headquarters, or mounted silver prints.
>
> Each department is to number its photographic negatives in a series of its own, beginning with No. 1, and to keep an index of photographs, with a cross-index by numbers and the necessary cross-references. Each plate is to be marked in or near the lower right corner with subject, location, date and number, the department letter being placed before the number with a space between. Plates are to be stored in places which will be designated by Headquarters' office by the department engineer.
>
> Department engineers may furnish division and section offices with prints as they are needed, these prints to be indexed as already provided for department offices. Blue prints will probably be sufficient for these purposes.
>
> Prints of official photographs must not be furnished gratis for private use. If feasible, arrangements will be made by which individuals may, with the permission of the department or division engineer, secure prints of specified photographs at cost.
>
> Official files of photographs in Headquarters and field department offices are to be kept in standard 8½ × 11-in. letter file drawers. Files are to be divided, so as to keep photographs of real estate, construction-progress photographs, and photographs for accident and damage cases separate. Each class should be subdivided by metal-tip guide cards according to locality or subject. In each subdivision the pictures should be arranged in chronological order. An OUT card should be used if a photograph is taken from the file.

On explorations, reconnoissances and surveys the smaller sizes of the folding kodaks are found very convenient. The writer, while Chief Engineer of the Mathieson Alkali Works at Saltville, Va., used one of these cameras largely on horseback reconnoissances for proposed railroad lines. His equipment consisted of an 1894 model 4 × 5-in folding kodak, with film holder for a roll of film of 100 exposures. The camera was "loaded" before starting out. In addition the

*606 Ashland Ave., Buffalo, N. Y.

carried extra rolls of film, sometimes as many as six, each of 100 exposure capacity, also a folding red lantern to be used for changing films and inserting fresh ones. In nearly every case instantaneous exposures were made, and on horseback, the idea or plan being to show the country through which a probable railroad would pass. A record of each exposure was kept, number, date, time, subject, etc., and upon a film roll becoming exhausted it was taken out, mailed for factory development. Factory prints were made and mounted in a book, four to the page, in the order in which the exposures were made. This was for ready identification; the subject was entered under the print as soon as the book was received from the factory.

On various reconnoissances, over 1,500 exposures were made of which 96% were generally good. In other words, there were usually 96 good pictures from a 100-exposure roll.

Owing to the limited demand for this style of camera, the makers have discontinued the manufacture and sale of the same. It is, however, possible to obtain films of this capacity through special order. This old-style camera has been superseded by the daylight-loading cameras, using film cartridges for either 6 or 12 exposures, with the added advantage of being able to develop a small number of exposures instead of waiting until the whole roll is exposed.

After leaving the Mathieson Alkali Works, the writer was fortunate in going to a work of great importance on which he took a total of over 2,000 photographs. Owing to the magnitude of the photographic operations, a complete system was arranged covering all work from exposure to final filing.

The camera used was a 1897 model 5 × 7-in. folding kodak, using first the lens accompanying it, but later substituting a "Goerz." The camera was primarily a film camera, fitted with a roll holder capable of holding a roll large enough for 100 exposures. It was so arranged, too, that glass-plate holders could be used, six being supplied with the camera, of which three were carried in the space occupied by the roll holder and three in a special leather carrying case. These six holders thus held twelve glass plates, the regular number in the ordinary box. A tripod was provided for time exposures, but nearly all were instantaneous, many of the views being taken over the water, where a tripod could not be used.

A 7 × 7-ft. dark room was built in the corner of a large room. It was equipped with a large sink, running water, shelves, drawers, racks, etc. The room was ventilated, and lighted by electricity.

For office records, the prints were mounted on Gilson adjustable leaves, one on each side, the photographs having been first assembled according to certain arbitrary subjects. A separate album was used for each subject.

A few words should be said on the advantage of photographing "contract maps." The 8 × 10-in. plate is a good size and the original maps should be on sheets 31½ ins. long by 24 ins. wide to allow a reduction of 3 to 1, the photographic prints being on paper 8 × 10½ ins., which gives ½-in. extra margin. The reduced contract drawings of the Bureau of Water, City of Syracuse, N. Y., are good examples of this kind of work.

On small work, elaborate outfits are not needed and small cameras are widely used, preference apparently being given to the many kodaks. These notes should not close without mentioning a new camera known as the No. O. Graphic. It is a fixed focus and with the lens wide open everything up to within 12 ft. is microscopically sharp. The camera is very small, the picture being only 1¾ × 2⅝ ins., but the views will furnish fine enlargements.

COMMERCE ON THE GREAT LAKES in May, 1911, showed a considerable reduction below that in May, 1910. The freight tonnage during the month, as reported by the Bureau of Statistics of the Department of Commerce and Labor, was 8,755,205 short tons, as compared with 11,253,988 short tons in May, 1910, and 7,607,546 tons in May, 1909. The decline in total traffic is chiefly due to smaller shipments of iron ore from Lake Superior and Michigan ports.

Annual Meeting of the Master Car Builders' Association.

The 45th annual convention of the Master Car Builders' Association was held June 19-21, at Atlantic City, N. J., following the convention of the American Railway Master Mechanics' Association, reported in our issue of last week. A very large attendance was present, made up largely of the same men who attended the Master Mechanics' convention, though there were many changes in faces to be noted. For the first time since the conventions have been held in Atlantic City, the "Greek Temple" meeting room on the "Million-Dollar Pier" was not large enough to care for the attendance, and it was very evident that some more extensive accommodations will have to be provided next year. As usual the work of the convention was directed toward the perfecting of the details of car construction and the adjusting of disputes which have arisen during the year in the interchange of cars between the various roads. The proceedings seemed more than ever to be concerned with the minor details of construction, in the effort to bring to a standard all of the many parts which go to make up the modern railway car, and with the exception of the action in regard to a standard coupler, noted below, there was little of more than routine interest brought forward.

As in the convention of the previous week, the proposed consolidation of the Master Mechanics' Association with the Master Car Builders' Association was brought before the convention by the report of a committee which announced that according to the best advice the proposed reorganization would be legal. In contradistinction to the other convention, however, it was very evident that most of the members were against any such move. There are certain moving spirits in the Master Car Builders' Association who are, as a rule, the heads of the mechanical departments of their respective railways and who are also among the leaders of the Master Mechanics' Association. These men earnestly wish a consolidation of the two societies, for reasons set forth in the committees' report last year and reported by us at that time, and they are making every effort to bring this consolidation about. At the same time there are a great many members of the Master Car Builders' Association, who are only members of the car department of their railways and they are distinctly opposed to any action which, as they think, would destroy the identity of their association. The matter is therefore at a standstill and promises to remain so for some time.

The Secretary reported that the number of cars now represented in the Association is 2,464,530, an increase of 165,899 over last year.

President's Address.

The address of the President, Mr. T. H. Curtis (Louisville & Nashville R. R.) was devoted to several specific recommendations for improvements in standards in couplers, car-wheels, brake shoes, brake-beam safety hangers and air-brake hose and an earnest plea for a wider observance of the standards of the Association. On July 1, 1911, the new federal safety appliances act goes into effect; and after that date all railways will be required to keep their equipment up to higher standards than ever before. It, therefore, behooves all the railways to observe more closely the standards set down in the Association records. Regarding the previous observance of these standards, Mr. Curtis said:

> The 24th annual report of the Interstate Commerce Commission contains a report of the chief inspector, J. W. Watson, in the summary of which it is shown that in the year ended June 30, 1910, nearly a half-million freight cars were inspected and a little over 5% were found to be defective. When comparing these figures with those for the year ended June 30, 1905, in which about one-fourth of a million freight cars were inspected and over 22% were found to be defective, we have the comfort of knowing that an improvement was made, but there is still room for further effort. The comparative classified table of defective safety appliances on freight cars, for the year ended June 30, 1910, as to couplers and uncoupling devices, shows over 5,000 defective appliances. Over 1,500 of these defects were in the uncoupling chains. These could have been practically obviated by the use of a first-class chain that would not have cost over 15 cts. Over 2,000 more of the defects reported could have been righted within an average of one-half hour's time for each defect, and at a cost of not over 50 cts. each. Over 6,000 cases of defects were reported in hand-holds, ladders and sill-steps. Of this number, over 600 were for missing sill-steps and nearly 4,000 for missing handholds. These omissions are to be deeply regretted. As to air brakes, over 16,000 cases were reported, of which over 6,000 were for brakes cut-out and over 2,000 for cylinder and triple valves not having been cleaned within the prescribed time. There were over 2,000 cases of release rods missing. These rods do not cost over 10 cts. each.
>
> Of the 16,000 defects cited, 10,000 of them could have been repaired by detaining the car from service only a half-day at the most, and these repairs would have required only labor and they would not have required the services of large shops and machinery. The greater portion of the defects mentioned could have been obviated by greater care and supervision, and this supervision should have come from the higher officers. They should have known that the car men were properly instructed and drilled in regard to the importance of properly applying and maintaining safety appliances.

Committee Reports.

Two of the committee reports were too lengthy and involved to be more than noted here, the one on Revision of Standards and Recommended Practice and the one on Rules of Interchange. The former report is the regular revision of the details of car construction and the latter the annual decision of the Arbitration Committee on the matters of car interchange. While undoubtedly the most important business transacted by the Association, neither of these reports lends itself to an abstracted account. In addition to these there were also presented in more or less detail 17 other committee reports, the most important of which was that of the Committee on Coupler and Draft Equipment.

STANDARD COUPLERS.—The Committee on Coupler and Draft Equipment presented a report which drew forth a discussion and action by the Association of considerable importance. The recently enacted federal safety-appliance law provides that within five years all freight equipment shall have an end-ladder clearance somewhat in excess of that possible on most cars as now built. It therefore becomes necessary that either the draft-rigging on these cars be moved forward or else a standard coupler of longer length must be designed. To meet this difficulty the commitee suggested that one, or not more than two, *temporary* standard couplers be adopted, providing a sufficient length to secure the necessary end clearance. It also suggested that inasmuch as any extension in the length of the coupler shank would probably involve changes in the end construction of the car and a greater liability of bent coupler shanks, the necessary clearance should be gained by changing the present standard distance between inside face of knuckle and striking horn of coupler. This coupler is intended only to meet the present emergency for cars already built, the end clearance to be cared for otherwise on new cars. The committee asked instruction on this point.

The convention, through many opinions expressed on the floor, was opposed to any increase in coupler standards and finally, after much discussion, adopted a resolution instructing the committee to design an M. C. B. standard coupler to be presented to the next annual convention. The committee was further authorized to confer with representatives of the coupler manufacturers and to secure the services of a competent mechanical engineer to assist in the work. Meanwhile the committee was instructed to prepare a design for the temporary coupler mentioned to be presented to the Executive Committee and, if approved by that committee, to be sent out to letter ballot before the next annual convention.

This move toward a standard M. C. B. coupler is one which has been frequently advocated on the floors of previous conventions but which, apparently, needed the spur of government regulation for final action. There is already a standard contour for couplers adopted by the Association, but under this contour there are as many couplers as there are manufacturers. This requires a very large expense in the stock houses

of each railway in order to repair the varied equipment from all roads. One railway, for instance, reported that last year it had to order over 10,000 knuckles of 39 different makes and 7,000 knuckle locks of 21 different makes. Furthermore, it is becoming apparent that under the heavy loads now carried the present couplers are not reliable and that under service they are very apt to get out of gage. It is apparent that, aside from the necessities of the new clearance regulation, the time is more than ripe for the adoption of a standard coupler which can be used by all roads. The action of the Association at this convention is, therefore, a most important one which should lead in the next few years to both a saving in stock charges and a greater safety in equipment.

The committee also reported that the draft-gear tests proposed last year could not be carried out, on account of the large expense involved in the construction of a testing machine.

SAFETY APPLIANCES.—The United States law standardizing safety appliances on railway cars goes into effect on July 1 of this year for all new cars to be built and is extended for various periods up to five years for putting old cars into correct condition. The committee recommended that in the particulars where the federal standards differed from the M. C. B. standards the latter be changed to conform to the former. It further recommended a standard badge to be placed on all cars conforming to these required standards. These recommendations were adopted and sent to letter ballot.

There was some little disposition on the part of certain members to change in a minor way the recommendations of the committee as to the method of marking standardized cars and this brought forth a general expression of opinion that it would be better for the railways to conform in every particular to the agreements made between the representatives of the railways and of the Interstate Commerce Commission in this matter of safety appliances. Several members stated, in effect, that had the railways in the past been more disposed to recognize the safety requirements of the Association they would not be subjected to such drastic legislation as is now being forced upon them, and the best way to prevent this legislation growing more drastic is to follow out the present laws in letter and spirit.

TRAIN BRAKE AND SIGNAL EQUIPMENT.—This committee presented a voluminous report on various detailed subjects submitted to it from the last convention. The main portion of these items was the recommendation for a standard air-brake hose coupling and a standard packing ring for these couplings. These recommendations were sent to letter ballot.

BRAKE-SHOE EQUIPMENT.—The report of this committee is in two parts, the first devoted to brake shoes, the last to brake beams. This latter is entirely upon details of dimensions and design and will not be abstracted here. The former relates to a number of tests made during the past year, which show that there is no apparent difference between the coefficient of friction as observed on the regular testing machine, with pressure applied by dropping weights and as observed by a special air-brake cylinder machine giving substantially service conditions. The committee further reported that

> The tests were made at a speed of 80 m. p. h., and since the previous work of the Committee does not involve such speeds, it has been impossible to tie up the results of the present series with those which have already been made of record. For this reason, it is impossible to judge from them the sufficiency of the present specifications for use in selecting shoes for very high-speed service. It has been suggested that in all probability a shoe which gives the best results under the present specifications will at least give good results under the higher speeds and pressures, such as are now being considered.

CAR WHEELS.—This committee submitted a communication from the manufacturers of chilled car wheels which stated that under present conditions with high braking pressures, the limiting factor for each weight of wheel is the temperature stresses set up on account of the rapidity with which heat is generated on the surface of tread of the wheel under heavy and continuous braking. The manufacturers wish a maximum braking power set for each capacity car, but considering this impracticable recommend heavier weights of cast-iron wheels. The committee reserved recommendation until next year.

The committee also reported that the maximum diameter of steel or steel-tired wheels to maintain a maximum drawbar height of 34½ ins. should be 33 ins. The minimum diameter to maintain a 31½-in. drawbar height was so varied that the committee could not recommend a standard.

Some slight changes were recommended in the details of wheel design. The report was sent to letter ballot.

REFRIGERATOR CARS.—Outside of some details of dimensions the report of this committee is important because it states that it appears to be a mechanical impossibility to design a non-freezing drip cup for refrigerator cars. A representative of a packing company stated that everything was being done to perfect appliances whereby the brine could be kept off the track and could be drawn off at the icing stations.

STEAM HEATING CONNECTIONS.—The report of the Committee on Train Pipe and Connections for Steam Heat was a recommendation that certain Recommended Practices be advanced to Standard. The report was not accepted but was referred back to the committee with the recommendation that it consider the entire subject of steam-heat hose connections for passenger train service.

OTHER COMMITTEES.—The Committees on Freight Car Trucks and Springs for Freight Car Trucks presented no reports. The Committee on Lumber Specifications considered last year's specifications ample and therefore did not report. The Committees on Train Lighting and Equipment, Revision of Code, of Tests and Rules for Loading Materials presented reports with minor corrections of previous standards.

Officers.

The following officers were elected for the coming year: President, A. Stewart (General Supt. of Motive Power, Southern Ry.); First Vice-Pres., C. E. Fuller (Asst. Gen. Mgr., Union Pacific Ry.); Second Vice-Pres., D. F. Crawford (Gen. Supt. of Motive Power, Pennsylvania Lines West); Third Vice-Pres., M. K. Barnum (Gen. Supt. of Motive Power, Illinois Central R. R.). The Secretary of the Association is Jos. W. Taylor, 390 Old Colony Bldg., Chicago, Ill.

Semi-Annual Meeting of the American Institute of Chemical Engineers.

The third semi-annual meeting was held at the Congress Hotel, Chicago, on June 21 to 24, with a rather light attendance.

CHEMICAL ENGINEERING EDUCATION.—At the opening session, on the morning of June 21, the principal subject dealt with was that of special education for the chemical engineer. Dr. S. P. Sadtler presented the report of the Committee on Chemical Engineering Education, and was followed by Prof. J. H. James with a paper on "The Four-Year Chemical Engineering Course." Among other matters this paper discussed the differentiation of the mechanical engineer who designs the machinery of a chemical industrial plant, the chemical engineer in charge of laboratory or research work, and the chemical engineer in charge of commercial or industrial work on a large scale. Another paper was read, which discussed a five-year educational course. It had been expected that the paper would be followed by discussion from professors who are engaged in teaching engineering, but there seemed little desire to open a discussion, and the meeting adjourned for one of the excursions.

EXCURSIONS.—A considerable proportion of the time of the meeting was devoted to excursions. These included the plants of the Corn Products Refining Co., at Argo, Ill. (described is our issue of Aug. 26, 1909); the By-Products Coke Co., at South Deering; the Carter White Lead Co., at West Pullman; the Indiana Steel Co., at Gary, Ind.; the Universal Portland Cement Co., at Buffington, Ill.; the Illinois Steel Co., at South Chicago, Ill.; and the Standard Oil Co., at Whiting, Ind.; also the laboratories of the Dearborn Drug & Chemical Works, at Chicago.

At one of the evening sessions there was an address descriptive of methods of attacking chemical industrial problems. This was illustrated by lantern slides showing drawings and photographs of several industrial plants.

METHODS OF TESTING ASPHALT PAVING.—A paper by Prof. S. F. Peckham discussed two methods of determining the qualities of asphaltic paving materials submited under specifications which called for Sicilian rock-asphalt mastic or a mastic equal thereto. The first method of testing determined the total amount of bitumen in the mastic, and the different sizes of sand mixed with it; it included also a test by loading blocks of the mastic 4 ins. square with a weight of 10 lbs. These tests proved to be inadequate to determine the respective qualities of the two kinds of mastic. The method employed by Prof. Peckham consisted in treating equal weights of the two samples of mastic with the same solvent, and noting the effects both as to the quality of the solutions obtained and the amount of material dissolved. From these tests it appeared that one mastic was prepared from European rock asphalt and the other from petroleum residuum.

CALORIFIC TESTS OF ANTHRACITE COAL.—Another paper by Prof. Peckham was on "The Practical Value of Calorific Tests on Anthracite Coal." This discussed the results of the analyses of 100 samples of anthracite coal, including the different sizes of anthracite delivered at stations around New York City. Analyses were made by combustion, and the determination of the fixed carbon and ash; the same samples were treated also by the Mahler bomb process for the determination of B. T. U. developed by the combustion. As a rule, the B. T. U. thus developed were in inverse proportion to the amount of ash contained in the coal. The conclusions presented were as follows:

(1) The gathering of samples over the great area of Greater New York, where coal is delivered at 1,200 stations, could be accomplished only with considerable difficulty and expense, the expense sometimes exceeding the value of the delivery. (2) The testing of the samples by the determination of volatile matter, water, fixed carbon and ash is a simpler matter; it is rapidly executed and capable of exact determination. (3) The determination of B. T. U. furnished no additional useful information as to the quality of the sample. It was performed with delicate apparatus requiring skill in its use, furnishing results which can be duplicated only within wide limits and which are therefore of doubtful practical value.

DISTILLATION ON THE CONTINUOUS SYSTEM.—This paper by Mr. Charles M. Campbell presented an outline of the theory and practical application of this system in the manufacture of distilled products, such as alcohol, wood alcohol, ether, etc. It was stated that European countries are much in advance in this direction, and that American manufacturers are only now awakening to the economies which may be effected.

A NEW LINING FOR CHEMICAL APPARATUS.—Mr. Charles M. Campbell had also a paper on "A New Process of Lead and Silver Lining for Chemical Apparatus." Various processes have been used to apply to such apparatus a protective lining of lead or silver, either by electroplating or by placing a sheet of the material inside copper or iron pipes and vessels. A new patented process is said to avoid the drawbacks of earlier processes, and to ensure a uniform coating with complete adhesion to the metal of the pipe or vessel; the apparatus so treated is cheaper than solid silver and lighter than solid lead, while the heat conductivity is said to be equal to that of vessels of the solid metal.

THE U. S. PATENT SYSTEM.—A paper by Dr. Wm. M. Grosvenor discussed the defective features of the system, and gave the causes of unproductive invention as (1) mistaken ideas as

to the relation between inventor and attorney, and (2) the mistaken attitude of the inventor toward commercial exploitation. It was suggested that the Institute should be enlightened by papers written by expert patent attorneys, and that it should cooperate with other technical societies in securing the enactment by Congress of legislation to improve the patent system.

A Professional Code and Schedule of Fees for Consulting Engineers.

The American Institute of Consulting Engineers, a society formed a few years ago in New York City for dealing with professional questions, has just completed two of its earliest undertakings by formulating a code of professional ethics and a schedule of charges for consulting, designing and other engineering service. A strong committee was appointed last January to deal with the subject of Professional Practice and Ethics; it consists of Mr. John F. Wallace (Ch.), Mr. H. W. Hodge, Mr. L. B. Stillwell, Mr. F. A. Molitor, and Prof. Geo. A. Swain. The present code represents the results of this committee's work with slight changes suggested by the Council and by members of the society. The code has been approved by vote of the members, and was finally authorized by the Council on June 23, 1911. The members of the Council are Gustav Lindenthal, Ralph Modjeski, John F. Wallace, W. J. Wilgus, Rudolph Hering, C. O. Mailloux, Alfred P. Boller, J. E. Greiner and C. C. Schneider. Mr. E. W. Stern (103 Park Ave., New York), Secretary of the Institute, has furnished a copy of the code, which follows:

CODE OF PROFESSIONAL ETHICS.

It shall be considered unprofessional and inconsistent with honorable and dignified bearing for any member of The American Institute of Consulting Engineers:

(1) To act for his clients in professional matters otherwise than in a strictly fiduciary manner or to accept any other remuneration than his direct charges for services rendered his clients, except as provided in Clause 4.

(2) To accept any trade commissions, discounts, allowances, or any indirect profit or consideration in connection with any work which he is engaged to design or to superintend, or in connection with any professional business which may be entrusted to him.

(3) To neglect informing his clients of any business connections, interests or circumstances which may be deemed as influencing his judgment or the quality of his services to his clients.

(4) To receive, directly or indirectly, any royalty, gratuity or commission on any patented or protected article or process used in work upon which he is retained by his clients, unless and until receipt of such royalty, gratuity or commission has been authorized in writing by his clients.

(5) To offer commissions or otherwise improperly solicit professional work either directly or by an agent.

(6) To attempt to injure falsely or maliciously, directly or indirectly, the professional reputation, prospects or business of a fellow engineer.

(7) To accept employment by a client while the claim for compensation or damages, or both, of a fellow engineer previously employed by the same client and whose employment has been terminated, remains unsatisfied or until such claim has been referred to arbitration or issue has been joined at law or unless the engineer previously employed has neglected to press his claim legally.

(8) To attempt to supplant a fellow engineer after definite steps have been taken towards his employment.

(9) To compete with a fellow engineer for employment on the basis of professional charges by reducing his usual charges and attempting to underbid after being informed of the charges named by his competitor.

(10) To accept any engagement to review the work of a fellow engineer for the same client, except with the knowledge or consent of such engineer or unless the connection of such engineer with the work has been terminated.

SCHEDULE OF FEES.

As a general guide in determining fees for professional services, The American Institute of Consulting Engineers recognizes the propriety of charging: A per diem rate; a fixed sum; or a percentage on the cost of work; as follows:

PER DIEM RATE.—(1) Charges for consultations, reports and opinions should vary according to the character, magnitude and importance of the work or subject involved and according to the experience and reputation of the individual engineer, from $100 per day to a higher figure, and in addition where expert testimony is required or where otherwise conditions warrant so doing, a retainer varying from $250 to $1,000 and upwards. An additional charge should be made for all actual expenses such as traveling and general office expenses and field assistants and materials, with a suitable allowance for indeterminate items. In such cases six hours of actual work should be considered one day, except that while absent from the home city each day of 24 hours or part thereof should be considered one day, irrespective of the actual hours of time devoted to the case.

FIXED SUM.—(2) A fixed total sum for above mentioned services may be agreed on in lieu of per diem charges. A fixed sum may also be charged for a portion or all of the items of preliminary surveys, studies, examinations, reports, detail plans, specifications and supervision, including all of the expenses above recited under per diem rate.

PERCENTAGES ON THE COST OF WORK.—(3) For preliminary surveys, studies and report on original project, or for examination and report on project prepared by another engineer, including in both cases all expenses of every nature except those that may be specifically omitted by agreement—from 1½% to 3% on the estimated cost of the work.

(4) For the preliminary stage (3) and in addition thereto detail plans and specifications for construction, including all expenses of every nature except those that may be specifically omitted by agreement—from 2½% to 5% on the estimated cost of the work.

(5) For the preliminary and middle stages (3) and (4) and in addition thereto general supervision during construction, including all expenses of every nature except those that may be specifically omitted by agreement—5%, but more for work costing comparatively small amounts, and from 4% to 5% where the amount involved is considerable.

(6) For full professional services (3), (4) and (5) and management, including the awarding of contracts, and including all expenses of every nature except those that may be specifically omitted by agreement, 10%; but more for work costing comparatively small amounts, and 6% to 10% where the amount involved is considerable.

(7) When desired, the percentage basis may be adopted for one or more stages, supplemented by a daily or monthly charge or fixed sum for the remaining stage or stages.

GENERAL PROVISIONS.—(8) The period of time should be designated during which the agreed percentages and daily or monthly charges or fixed sum shall apply and beyond which period an additional charge shall be made.

(9) The percentages are to be computed on the entire cost of the completed work or upon the estimated cost, pending execution or completion.

(10) Payments shall be made to the engineer from time to time in proportion to the amount of work done.

(11) When alterations or additions are made to contracts, drawings or specifications, or when services are required in connection with negotiations, legal proceedings, failure of contractors, franchises or right-of-way, a charge based upon the time and trouble involved shall be made in addition to the percentage fee agreed upon.

A 3-FT. WATER MAIN BURST June 23 in New York City at the corner of Broadway and 129th St. The escaping water forced its way through the 4 ft. of overlying earth and gravel and through the asphalt pavement, spurting into the air in a fountain 6 or 8 ft. high. The break occurred at about 2 a. m. and it was nearly three hours before the flow was entirely stopped. It is estimated that several million gallons of water were lost. Property damage amounting to many thousand dollars was done by the flooding of basements in the vicinity. In the car house of the Third Avenue Railroad Co. at 129th St. near Manhattan St., the electric elevator, used for raising cars to the second floor, and the transfer table were put out of commission for many hours by the flooding of their pits.

THE 328-FT. REINFORCED-CONCRETE ARCH bridge across the Tiber at Rome, Italy, was opened for traffic on May 12 of this year. As has been stated before, this is the longest span masonry arch bridge yet built, surpassing by 8 ft. the Grafton concrete arch at Auckland, N. Z., and by 33 ft. the Plauen arch in Germany, the largest stone voussoir arch in existence. A recent article in "L'Ingegneria Ferrovaria," of Rome, describes the construction of the bridge briefly, but does not take up the design in any detail. The bridge is intended primarily to provide a passageway over the Tiber to an exposition that is to be opened this summer and was not projected until about May, 1909. The time for its necessary completion was then very short so it was at first thought best to build a wooden structure. This was opposed by the municipal authorities who desired a permanent bridge at just this location, so it was decided to build the bridge of reinforced concrete, as being both rapid in construction and permanent in character. Many studies were made for the design of so extraordinary a span, and the design submitted by "La Societa Porcheddu Ing." was accepted after a conference of a special commission appointed for the purpose. The contract under this design was awarded to a firm composed of Messrs. Porcheddu and Bentivegna for the sum of 1,250,000 lire ($238,000), and work was started on Nov. 11, 1909.

The bridge consists of a single arch span across the river, 100 m. (328.1 ft.) in span and 10 m. (32.8 ft.) in rise, and has a roadway 43 ft. wide flanked on either side with a 10-ft. sidewalk. It comprises seven separate no-hinged arch ribs, each 20 cm. (8 ins.) deep at the crown and 50 cm. (20 ins.) deep at the spring and 20 cm. (8 ins.) thick throughout the arch span, widening to a thickness of 30 cm. (12 ins.) in the continuation into the cellular abutment. All of the arches are tied together with transverse and horizontal diaphragms and are topped with a reinforced-concrete slab forming the roadway. The abutment is of the cellular type resting on a concrete slab bottom which in turn is founded on piles formed by the "Compressol" system. The ribs and diaphragms are reinforced throughout, though the amount of the reinforcement is not available to us at present. The bridge was designed for a load over the entire surface of 500 kg. per sq. m. (100 lbs. per sq. ft.) and a rolling load of three 16-ton road rollers. The bridge is known as the Ponte del Risorgimento.

THE GOWANUS CANAL FLUSHING TUNNEL, in Brooklyn, N. Y., was formally put into operation June 21. The canal, which has a total length of about two miles, opens into New York Bay at one end only. Consequently, there is practically no flow of water through the canal, the only movement being the rise and fall due to the tide. Waste material from numerous factories along the canal and refuse from various other sources have been accumulating in the stagnant water for years. At the time the flushing tunnel was put into operation conditions were such as to be not only objectionable to the men employed on tugs and barges, but a public nuisance to every one over a considerable area of the city. From the head of the canal to the Hamilton Ave. Bridge, a distance of one mile, the width is 100 ft. and the depth from 7 to 12 ft. at low water. Below the bridge the canal is considerably wider.

In 1905 the construction of a flushing tunnel was authorized by the Board of Estimate, and construction was begun in 1906. It was originally planned to pump water from the East River through a tunnel into the canal, but the plan finally adopted was to pump water from the inner end of the canal through the tunnel out into the East River, or strictly, into Buttermilk Channel, where it would be carried away by the tide currents. The tunnel is 6,280 ft. long, extending from the head of the canal at Butler and Nevins Sts. to the foot of Degraw St. opposite Governor's Island. The diameter of the tunnel is 12 ft., and it is at the same level from end to end, with the top of the tunnel 2 ft. below mean low water. It is lined with 16 ins. of brick and is practically water-tight. Its depth below the surface varies from 65 ft. at the deepest point to 8 or 10 ft. at the ends. The tunnel was dug, with steel shields and compressed air, in both directions from a shaft sunk at the middle of its length. It passes under important streets and had to be completed with no injury to any of the buildings. Although the material passed through was coarse sand and gravel, which was, of course, full of ground water, this was successfully accomplished, and in fact for distances of some blocks there was even no disturbance of the street pavement.

The power-house or pumping station is located at the head of the canal. The pump is of the screw-propeller type. The propeller is mounted on a horizontal shaft 9 ins. in diameter in the throat of a Venturi tube, which forms a part of the tunnel. The throat diameter of the Venturi tube is 9 ft., which is 3 ft. less than that of the tunnel. The propeller was specially designed for this installation by David W. Taylor, U. S. Naval Constructor. Only about ¼-in. clearance is left between the propeller and its casing. It is driven at a speed of 120 r. p. m. by a 500-HP. alternating-current, three-phase motor, taking current at 550 volts. Current for the motor is purchased from the Brooklyn Edison Co.

The propeller pump and motor are set in a pit 30 ft. in diameter and about 30 ft. deep, it being necessary for the propeller shaft and its direct-connected armature shaft to be at the level of the center line of the tunnel. The propeller shaft is nearly 50 ft. long. It enters the tunnel at a bend near the opening into the canal. Two 12-ft. gate valves are provided in the tunnel, one on each side of the propeller, by means of which the section in which the propeller stands can be cut off from the rest of the tunnel and it can then be pumped dry if desired. This permits access to the propeller for making repairs.

The plant was in operation intermittently for some ten days before it was formally opened. Rough measurements of the amount of water handled showed that it was probably fulfilling its guarantee of a capacity of 30,000 cu. ft. per min. No accurate tests have yet been made to determine the efficiency of the plant. The contract provided that for every 1% efficiency shown on the acceptance test above 35% a bonus of $1,000 should

be paid to the contractor, but that a penalty of $1,000 could be claimed for every 1% below 54% efficiency. The plant would not be accepted at all unless an efficiency of at least 48% was shown. The effect of the plant is already discernible in the improved condition of the water in the canal. The pump is kept in operation during the ebb tide, when the discharge into Buttermilk Channel will be carried seaward. At this time the normal flow in the canal would be from the head out toward the mouth. With the pump in operation, however, the tide current in the canal is not only overcome, but a current with about twice the velocity is set up in the opposite direction.

The work of construction was done under the supervision of Mr. E. J. Fort, Chief Engineer, Brooklyn Bureau of Sewers. The John Pierce Co. was the contractor for the tunnel and Henry E. Fox for the pumping plant. The cost for the tunnel alone was $715,000 and of the complete flushing system about $950,000.

Personals.

Mr. Harvey H. Brown, brother of the late Alexander E. Brown, has been elected President of the Brown Hoisting Machine Co., Cleveland, Ohio.

Mr. David L. Robertson, has been appointed Assistant Engineer of the New York Central & Hudson River R. R., with headquarters at New York City.

Mr. George W. Vallery, General Manager of the Colorado Midland Ry., has been elected President of that road, succeeding Mr. A. D. Parker, resigned.

Mr. C. H. Chamberlin, M. Am. Soc. C. E., formerly Assistant Chief Engineer of the Texas & Pacific Ry., has been appointed Chief Engineer of the same.

Maj. B. S. Wathen, M. Am. Soc. C. E., formerly Chief Engineer of the Texas & Pacific Ry., has been appointed Consulting Engineer, with headquarters at Dallas, Tex. Maj. Wathen entered the railway service in 1865 as a rodman on the Louisville & Nashville R. R. From 1870 to 1874 he was Locating Engineer and Assistant Chief Engineer of the International & Great Northern Ry. After 1874, and until 1892, he was connected with the engineering departments of many of the southwestern and Mexican railways; as chief engineer and as locating engineer he has located many miles of railway in Texas. Since 1892 he has been Chief Engineer of the Texas & Pacific Ry.

Mr. C. H. Rae, General Master Mechanic of the Louisville & Nashville R. R., has been made Assistant Superintendent of Machinery, succeeding Mr. C. F. Giles, promoted.

Mr. C. B. Stanton, Associate Professor of Civil Engineering at Iowa State College of Agriculture and Mechanic Arts, has resigned to accept a position at the Carnegie Technical Schools, at Pittsburg, Pa.

Mr. Allen S. Miller, Assoc. Am. Inst. E. E., has become an equal partner with Mr. Alex. C. Humphreys, M. Am. Soc. M. E., President of Humphreys & Glasgow, Inc. The firm name is now changed to Humphreys & Miller, Inc.

Mr. W. A. Stearns, Mechanical Engineer of the Louisville & Nashville R. R., at Louisville, Ky., has resigned to become Assistant to the Chief Mechanical Engineer of the American Steel Foundries Co., of St. Louis, Mo.

Messrs. Frank J. Hoyte, of Pelham Manor; H. C. Merritt, of Tuckahoe, and J. L. Hayes, of Yonkers, N. Y., are the ones appointed by Governor Dix to fill the places of the Bronx Valley Sewer Commissioners who were recently relieved of their offices.

Mr. F. G. Jonah, M. Am. Soc. C. E., formerly Chief Engineer of Construction of the St. Louis & San Francisco R. R., at St. Louis, Mo., has been appointed Chief Engineer of the New Orleans, Texas & Mexico and the St. Louis, Brownsville & Mexico Rys.

Mr. William H. Kimball, M. Am. Soc. C. E., of Davenport, Iowa, has been appointed a member of the Levee Improvement Commission of that city. This commission will have charge of the improvement and administration of the Mississippi River frontage within the city's limits.

Mr. C. A. Jennings, in charge of the Bubbly Creek water-purification plant at the Chicago Stock Yards, has been granted leave of absence until August. He will act as expert for several cities in the Pacific coast states in the installation of hypochlorite-of-lime water-purification plants.

Dr. Michael I. Pupin, Professor of Electro-Mechanics at Columbia University, New York City, has been designated to serve as director of the Phoenix Research Laboratories of the University. In this capacity Dr. Pupin will have general charge of the research work of the department of physics.

Mr. Calvert Townley, M. Am. Inst. E. E., has resigned his position as Vice-President of the Connecticut Co., the holding company of the New York, New Haven & Hartford R. R. Co.'s electric railway lines, to resume his connection with the Westinghouse Electric & Manufacturing Co., of Pittsburg, Pa.

Messrs. Charles G. Rush and Henry B. Otis, Assoc's. Am. Inst. E. E., have formed a partnership as electrical contracting engineers. They will carry on the business of C. G. Rush & Co. under the new firm name of Rush, Otis & Co., with offices in the Title & Trust Bldg., 69 West Washington St., Chicago, Ill.

Mr. James M. Marker, Chief Engineer of Ohio State Board of Public Works, has been appointed State Highway Commissioner of Ohio at a salary of $4,000 per annum. As Commissioner he will have supervision of the expenditure of about $1,000,000 yearly for the next two years, and will have charge of the organization of a highway engineering corps to carry out the work.

Mr. F. D. Bardwell has been appointed Special Assistant Engineer of the Electric Zone Construction Department of the New York Central & Hudson River R. R., succeeding Mr. L. H. Byam, M. Am. Soc. C. E., resigned. Mr. H. M. Bassett has been appointed Assistant Designing Engineer, vice Mr. Bardwell, and Mr. H. H. Sherwin has been appointed assistant to the Engineer of Structures, vice Mr. Bassett.

Mr. George H. Whitfield, M. Am. Inst. E. E., for many years General Superintendent of Light and Power, of the Virginia Ry. & Power Co., of Richmond, Va., has resigned to devote his entire time to the practice of consulting engineering. Mr. Whitfield graduated from Richmond College in 1892 and from Cornell University in 1896. Previous to going to Richmond he was connected with the electric railways of Baltimore, Md., and San Francisco, Cal. In addition to his regular work Mr. Whitfield has been engaged in designing the electrical features of several other electric power properties.

Mr. Charles F. Scott, Past-President Am. Inst. E. E., for a number of years the Consulting Engineer of the Westinghouse Electric & Manufacturing Co., has been appointed Professor of Electrical Engineering at Sheffield Scientific School, Yale University. Mr. Scott graduated from Ohio State University in 1885, later taking a post graduate course at Johns Hopkins University. He has always been especially interested in educational work and has been associated with the apprentice system of the Westinghouse Co. for a number of years.

Mr. J. P. Snow, M. Am. Soc. C. E., Chief Engineer of the Boston & Maine R. R., has resigned, to take effect July 1. Mr. Snow is a graduate of the Thayer School of Civil Engineering, Dartmouth College, and was for many years Bridge Engineer of the Boston & Maine R. R., becoming Chief Engineer a few years ago. He is a Director of the American Society of Civil Engineers. Mr. Snow is succeeded by Mr. A. B. Corthell, M. Am. Soc. C. E., Secretary and Consulting Engineer for the Auxiliary Facilities Committee, Grand Central Terminal, New York City, who has also been made Consulting Engineer of the New York, New Haven & Hartford R. R.

Mr. Charles Saville, formerly Assistant Engineer to the Massachusetts State Board of Health and at present Assistant to Dr. K. Imhoff, at Essen, Germany, where he has been engaged in the design of works for sewerage, sewage disposal and stream correction, will soon be associated with the firm of Hering & Gregory, New York City. Mr. Gregory, whose association with Mr. Hering was announced in our issue of last week, was for a number of years connected with the Metropolitan Sewerage Commission of Boston, Mass., and in the construction of the Metropolitan Water Works for Boston. Later he was Resident Engineer under Mr. Allen Hazen, M. Am. Soc. C. E., on the water-filtration plant at Albany, N. Y. Following this work he had charge of the designs for the filtration plant at Philadelphia, Pa. As Engineer in Charge he designed and built the water and sewage purification works at Columbus, Ohio. More recently he has been Resident Engineer for the Passaic Valley Sewerage Project, at Newark, N. J., and Engineer for the Metropolitan Sewerage Commission of New York City.

Obituary.

Clarence A. Knight, President of the Chicago & Oak Park Elevated R. R., died on June 22 in a Chicago hospital from appendicitis. He was 58 years old and noted as a corporation counsel.

Edward N. Crane, President of the Van Nostrand Co., Publishers, of New York City, died in Newark, N. J., on June 14, from acute indigestion. He was a member of the Engineers' Club of New York City and of several literary and social organizations.

C. A. Hague, M. Am. Soc. M. E., M. Am. Soc. C. E., Consulting Engineer, of 52 Broadway, New York City, died at his home in that city on June 23 from diabetes. Mr. Hague was the author of "Pumping Engines for Water Works," and had been engaged for many years as a consulting practitioner on water-works. He was a member of the American and the New England Water Works Associations.

Dr. Wilhelm Michaëlis, famous as an authority on hydraulic cements, died at his home near Hamburg, Germany, on May 14. He was born at Madgeburg in 1840 and spent his life in study and research work in chemistry, chiefly the chemistry of cement. He received his degree at Leipzig, where his graduation thesis was an early and important contribution to the literature of cement. Later he established a technical laboratory for the purpose of cement testing and became a consulting chemist for a number of Portland cement works. His study of cement covers continuous tests of over [illegible] years. He was among the first to recognize the properties of blast furnace slag as a cement-making material and his advocacy of its use for this purpose involved him in a long and bitter struggle with the German Portland cement manufacturers. Although for many years he was practically excluded from the Verein Deutscher Portland-zement Fabrikanten, he had an important influence in drawing up the German rules for uniform cement testing and was often consulted by individual members of the association, as on previous occasions. Not until 1897 did the association finally make peace with him. He had much to do with bringing about the conventions of engineers which led to the formation of the International Society for Testing Materials. He was also the inventor of sand-lime products and of an iron-ore cement. He took out patents on these cements several years ago but could not interest manufacturers in them. Not until recently, when his patents were expiring, did capitalists take hold of his processes, by which millions of sand-lime brick are now manufactured in the vicinity of Berlin alone. In 1906 he was made an honorary member of the German Cement Manufacturers' Associations in recognition of the numerous cement works in Germany and elsewhere which he designed.

Engineering Societies.

COMING MEETINGS.

AMERICAN SOCIETY FOR TESTING MATERIALS.
June 27-July 1. Annual meeting at Atlantic City, N. J. Secy., Edgar Marburg, University of Pennsylvania, Philadelphia, Pa.

AMERICAN CHEMICAL SOCIETY.
June 28-July 1. Annual convention at Indianapolis, Ind. Secy., Charles L. Parsons, Durham, N. C.

AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS.
July 6-8. Semi-annual meeting at Chicago, Ill. Secy., W. W. Macon, 29 West 39th St., New York City.

OHIO ELECTRIC LIGHT ASSOCIATION.
July 25-28. Annual convention at Cedar Point, Ohio. Secy., D. L. Gaskill, Greenville, Ohio.

TRAVELING ENGINEERS' ASSOCIATION.
Aug. 29-Sept. 1. Annual convention at Chicago, Ill. Secy., W. O. Thompson, N. Y. C. Car Shops, East Buffalo, N. Y.

INTERNATIONAL ASSOCIATION OF MUNICIPAL ELECTRICIANS.
Sept. 12-15. Annual meeting at St. Paul, Minn. Secy., Clarence R. George, Houston, Texas.

ASSOCIATIONS OF MEMBERS OF THE AMERICAN SOCIETY OF CIVIL ENGINEERS.—The Colorado association held its annual meeting in Denver June 17. An informal dinner was served, after which Mr. Gerald H. Matthes presented a paper on "The Hydraulic Features of the Shoshone Hydro-Electric Plant."

The bi-monthly meeting of the San Francisco association was held June 16 at the Palace Hotel. An illustrated address on "The South San Joaquin Irrigation Project" was presented by Mr. Edwin Duryea, Jr.

AMERICAN SOCIETY OF ENGINEERING CONTRACTORS.—The June meeting, which was the last regular monthly meeting until September, was held in New York City June 20. The evening was devoted to the discussion of the "Report on Uniform Specifications for Buildings" presented at the annual meeting in January, 1911, by Mr. Wm. B. Bamford, of Belmar, N. J. This report was published in the March "Journal" of the society. Those who took part in the discussion emphasized the importance of standardizing specifications and of adopting a single form of standard contract. The general trend was in favor of the "unit-price" contract as opposed to the "lump-sum," "cost-plus-percentage" and "cost-plus-fixed-sum" contracts. A full report of this discussion will appear in the June "Proceedings."

The annual convention, which is usually held in September, is to be omitted this year.

AMERICAN CHEMICAL SOCIETY.—Among the papers to be presented before the division of industrial chemists and chemical engineers at the annual meeting in Indianapolis, Ind., June 28-July 1, are the following: "Losses in the Storage of Coal," Horace C. Porter and F. K. Ovitz; "Need of a Professional Code of Ethics among Chemists," Francis L. Parker, Jr.; "Storage Battery Efficiency," J. S. Staudt; "A New Modification of Gas Analysis Apparatus," B. G. Klugh; "Refractories and Laboratory Appliances Made from Alundum," P. A. Boeck; "Determination of Vanadium in Vanadium and Chrome-Vanadium Steels," John R. Cain (to be presented by W. F. Hillebrand); "Determination of Dust in Blast Furnace Gas," L. A. Touzalin; "The Wood Distillation Industry of the Pacific Northwest," Henry K. Benson; "Ratfish Oil as a Paint Material," Henry K. Benson and Wallace Eshleman; "A Method of Analysis of Lead Ores," John Waddell; "Concentration and Purification of Iron Ore, High in Sulphur, by Roasting in a Rotary Kiln."